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一突變矮稻之顏色性狀及其他性狀之遺傳

稻之遺傳因子分析 第十報

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一、緒 言

關於臺灣之部分水稻品系如臺中 65 號，稗稈稻及一些突變稻之稃尖色，柱頭色、潁色及紫葉色等受花青素 (Anthocyanin) 支配的性狀，其遺傳行為，謝 (1960)，謝和張 (1962) 曾經報告，是受 *C* (Chromogen) 和 *A* (Activator) 兩補助遺傳因子 (Complementary gene) 之複對因子系列 (Multiple-allelic series) 組合理論及分佈因子 (Distributor) 所支配。而所謂分佈因子即將顏色分佈到各部位去之因子，如稃尖色之 *P* 因子，柱頭色之 *Ps* 因子，紫潁色之 *Pr* 因子及紫葉色之 *Pl* 因子等等。此點與 Nagao (1951)，Nagao and Takahashi (1956, 1962) 之花青素因子及花青素因子理論相符合。

有一突變稻，D-155-8 (d_{31})，其矮性因子與位於第二染色體連鎖羣（紫葉因子羣）之無葉舌因子 (*lg*) 有20%左右之連鎖值（謝 1962，嚴等 1968）。目前已知在此染色體連鎖羣中尚有許多其他重要之性狀，如柱頭色因子，紫潁色因子和石炭酸反應因子等等，但此矮性因子與上述因子間之關係尚不清楚。故本研究即在探討 D-155-8 之矮性因子與稃尖色、柱頭色、細葉等因子以及其他位於第二染色體連鎖羣上因子間之關係。

二、材料及方法

本試驗所用雜交親本中，一種係長尾博士 (Nagao) 及二種 Jodon 氏之遺傳因子標識稻 (Gene markers)，其餘均為保存於本研究室之材料，其中二種係在來種 (Indica type) 和三種蓬萊稻 (Japonica type)。這些親本與 D-155-8 雜交，F_1 植株種於網室中，F_2 植株在1965年左右種於田間。調查有關性狀。茲將有關之親本各種特性及遺傳因子符號等列於表 1。

表 1　供試材料特性表

Table 1. Strains used and their pertinent characteristics

系統號 Strains	系統名 Local names	推定遺傳因子型 Putative genic constitution	說明 Description	來源 Source
A-58	長尾氏系統 Nagao's strain	$C^B A\ Pr\ Ps$	紫色稃尖，柱頭及潁 Purple apiculus, stigma and hull	日本 Japan
T201	白米粉 Pei-mie-fen	*Ph*	石炭酸正反應 Phenol positive staining	臺灣 Taiwan (Indica)
T203	蟻公包 I-kung-pao	*Ph*	石炭酸正反應 Phenol positive staining	〃
J302	中村 Nakamura			日本 Japan
J317	戰捷 Sensho			〃
J327	木下糯 Kinoshitamochi	$C^B A\ Pr\ Ps$	紫色稃尖，柱頭和潁 Purple apiculus, stigma and hull	〃

1. 2. 臺灣省農業試驗所技佐及技正

7102	Jodon's strain	$C^{B} A\ Pr\ Pl\ Ps$	紫色稃尖，柱頭，穎及紫葉 Purple apiculus, stigma, hull and purple leaf	美　國 U. S. A.
7245	〃	$d\ Dn$	矮　性　　密　穗 Dwarfness,　dense panicle	美　國 U. S. A.
D-155-8	臺中155突變矮稻 Dwarf mutant from Taichung no. 155	$d_{31}\ nal$	矮　性　　細　葉 Dwarfness, narrow leaf	臺　灣 Taiwan

稃尖及柱頭之着色情形，於抽穗期間調查，以顏色之深淺，用不同之符號代表之，同時稃尖及內外穎之着色，除生育期間調查外，成熟後亦再觀察一次。石炭酸反應（Phenol reaction）則將谷粒浸於 1.5% 之石炭酸溶液 24 小時後，取出風乾再調查其陰陽性反應。其他各種形態性狀，如向地性（Laziness），脆性（Brittleness），細葉（Narrow leaf）和矮性（Dwarfness）等均在生育期間進行調查。

至於單獨性狀之實際與理論分離比適合度及兩性狀之連鎖情形等，則應用卡方值來測定。此外若有兩個組合以上具有相同之相關性狀時，則利用異質性測定（Heterogeneity test）來測定是否可以合併。如可合併，則以合併後之資料計算連鎖值。其連鎖值（Recombination value）是利用 Immer 氏（1930）積算法（Product method）或最大近似法（Maximum likelihood method）計算之。

三、試驗結果

1. 稃尖色之遺傳：

茲將親本F_1和F_2植株之稃尖着色情形，示如表 2，表中所有雜交組合均以 D-155-8 爲母本。在各雜交組合中，當 D-155-8 爲母本，與稃尖紫色品種 Nagao A-58 或 J327 雜交時，F_1植株之稃尖呈之紫色。F_2 植株之稃尖色分離爲 3 紫色：1 無色之比例，表示一對因子支配着此兩親本間稃尖色之遺傳。在另一方面，兩親本稃尖均無色之雜交組合，如 D-155-8×T201, D-155-8×T203 其 F_1 植株之稃尖表現出紫色，F_2 植株之稃尖色則分離成 9 紫色：7 無色之分離比，此表示，兩對補助因子支配着兩親間稃尖色之遺傳，且各親本僅具其中之一對因子。但這兩組合中，其 F_2 植株分離之實際數與理論數，不十分符合，其差異顯著機率介於 5 %與 1 %之間。而其餘兩組合其親本亦均表示此性狀之遺傳亦受兩對補助因子所支配，各親本亦僅具有其中之一對因子。在此兩組合中，其 F_2 植株分離之實際值與理論值間之卡方值爲0.58和2.78，均未達 5 %差異顯著標準。

表2　F_2稃尖及柱頭色之分離

Table 2. Segregation for coloration of rice apiculus and stigma in the F_2 populations

雜交組合 Crosses	母本 Female parent		父本 Male parent		F_1		結實率 Fertility %	F_2 植株稃尖色 F_2 Apiculus being				總數 Total	稃尖 Apiculus		柱頭 Stigma	
								有色 Colored		無色 Colorless						
								柱頭 Stigma		Stigma						
	ap	st.	ap.	st.	ap.	st.		+ 有色	− 無色	+ 有色	− 無色		分離比 Segregation ratio	X^2	分離比 Segregation ratio	X^2
D-155-8xT201	—	—	—	—	P	P	45	85	13	0	104	202	9:7	4.908*	13:3	1.938
D-155-8xT203	—	—	—	—	P	P	59	89	0	0	99	188	9:7	6.064*	1:0	
D-155-8xJ302	—	—	—	—	R	—	89	94(R)			82	176	9:7	0.577		
D-155-8xJ317	—	—	—	—	R	—	93	127(R)			122	249	9:7	2.784		
D-155-8xJ327	—	—	P	P	P	P	90	179	0	0	66	245	3:1	0.491	1:0	
D-155-8x Nagao A-58	—	—	P	P	P	P	94	143	0	0	52	195	3:1	0.289	1:0	

*…5%. 差異顯著　　*…Significant at 5% level of significance

2. 柱頭色之遺傳：

由於柱頭着色是稃尖着色之下位性因子（Hypostatic gene），故柱頭色之出現必須在稃尖有色之情形下，再加分佈因子（Distributor）*Ps* 方能表現。此可在表 2 中得到證明。我們由表 2 中再將柱頭着色形式，重新整理成表 3，在此表中可看到柱頭色之分離有三種不同的形式。第一種爲 D-155-8×T201 之形式：雙親之柱頭均無色，但 F_1 植株之柱頭却呈紫色，F_2 植株之柱色則分離爲13紫色：3 無色之比例，此表示有兩對遺傳因子之作用，其中一對且爲抑制因子（Inhibitor）。第 2 種爲D-155-8×T203 之形式：雙親之柱頭亦均無色，F_1 植株柱頭却呈紫色，而 F_2 植株上之柱頭色並未分離全部爲紫色。第 3 種情形爲 D-155-8×Nagao A-58 或 T327 之什交組合，此親本 A-58 及 J 327 之柱頭爲紫色，故其 F_1 植株之柱頭爲紫色，同時 F_2 植株之柱頭亦未分離，全部仍爲紫色。此表示上述第 2 、3 兩種情形之親本間具有相同之柱頭着色因子。

根據此等結果可假設，各親本之柱頭顏色因子型，Nagao A-58 和 J327 爲 Ps_1, Ps_2, $I\text{-}Ps_1$；D-155-8爲 Ps_1, Ps_2, $I\text{-}Ps_1$；T201爲Ps_1, ps_2, $i\text{-}Ps_1$；T203 爲 Ps_1, Ps_2, $I\text{-}Ps_1$。其中 $I\text{-}Ps_1$ 是 Ps_1之抑制因子，亦只能抑制 Ps_1 之表現能力。同時 Ps_1 和 Ps_2 爲兩對獨立之因子，分別支配柱頭之着色。

表 3　柱頭色之分離方式

Table 3. The different manners of inheritance of coloration of stigma

方式 Case	柱頭色 Stigma color		F_1柱頭色 F_1 stigma color	F_2 稃尖着色植株內柱頭色之分離比 F_2 stigma color segregation ratio in apiculus colored plant			備考 Note
	母本 Female	父本 male		+		−	
(1)	—	—	+	13	:	3	T201
(2)	—	—	+	1	:	0	T203
(3)	—	+	+	1	:	0	J327,A-58

3. 其他性狀之遺傳：

（1）細葉（Narrow leaf）：D-155-8 爲一細葉之突變體，高度亦只在 70cm 左右，此細葉性狀在 D-155-8×T201 等 9 雜交組合之試驗中，得 1619 株正常葉：515株細葉，此適合於 3 ：1 之分離些、證明此細葉性狀係受單一隱性因子所控制。此細葉性狀和矮性因子、顯色因子（*Ph*）、石炭酸反應因子（*Ph*）、無葉舌因子（*lg*）等均有明顯之連鎖關係。但與稃尖色因子 *C*、矮性因子 *d*(7245)、密穗(*Dn*)、莖脆性（*bc*）、向地性（*la*）等因子則相互獨立。

（2）穗型（Panicle type）：密穗（*Dn*）和正常穗植株間雜交，如D-155-8×7245什交組合中，F_1 植株是正常穗，但 F_2 植株則分離成186正常穗與53密穗，此適合於3：1之分離比，表示此性狀是由一對隱性因子所支配。

（3）石炭酸反應（Phenol reaction）：D-155-8×T201 及 D-155-8×T203 雜交組合 F_2 植株中，觀察到322陽性反應與87陰性反應植株，此適合於 3 ：1 之比例。表示陽性反應係受一對顯性因子所支配。

（4）向地性（Laziness）、脆性（Brittleness）和無葉舌（ligulelessness）：在 D-155-8×H-79 什交組合之 F_2 植株中觀察到87正常：31向地性。此外亦分別在 F_2 世代中，觀察到82正常：25脆；和89有葉舌：29無葉舌等之分離情形。表示此三種性狀均受單一隱性因子所支配。

（5）矮性（Dwarfness）或植株型（Plant type）：在兩親均屬矮性之 D-155-8×7245 雜交後代中。F_1 植株爲正常植株，F_2 植株則分離爲136正常植株：38株7245型：45株 D-155-8 型：9 株新矮型，此很適合於9：3：3：1之比例（P=0.67）。此即表示7245之矮性因子和 d_{31}(D-155-8)並

不相同，且兩者間並無連鎖關係。

（6）紫穎色與紫葉色：此兩性狀在 D-155-8×J327 及 D-155-8× Nagao A-58 兩組合中均顯示受一對顯性因子所支配。

表 4　兩性狀間獨立性測定值（X^2—值）

Table 4. Test of independence between various characters when two genes are concerned (X^2-Values).

	(7245)d	*D*n	*W*x	*l*g	*b*c	*l*a	*n*al	*P*s$_2$
(D-155-8)d$_{31}$	0.673(a)	3.042(a)					377.705(e)** 75.633(f)**	
*n*al	3.407(a)	3.501(b) 0.014(a)		21.312(d)**	0.868(d)	0.016(d)		17.262(f)**
A			0.179(c)				0.297(f)	
*l*a				1.852(d)	1.945(d)			
*b*c				3.778(d)				
*D*n	52.803(a)**							
*P*h							206.839(f)**	13.301(f)**
*P*r							86.019(c)**	88.124(g)**

a. D-155-8x 7245
b. D-155-8x J310
c. D-155-8x Nagao A-58
d. D-155-8x Nagao H-79
e. D-155-8x J301
f. D-155-8x T201
g. D-155-8x J327
**. Significent at 1% level significances
1％差異顯著

表 5　F_2族羣中兩性狀間之組換值

Table 5. The recombination values between two characters in the F_2 populations

有關性狀 Characters concerned	F_1因子型 F_1 genotype	雜交組合 crosses	聯合性狀 Combined characters				總數 Total	連鎖情形 Phase	組換值 Recombination value	機率 P
			AB	Ab	aB	ab				
Narrow leaf-purple hulll (3:1) (3:1)	$\frac{nal\text{-}pr}{Nal\text{-}Pr}$	D-155-8xJ327 D-155-8xNagao A-58	219	33	26	50	328	C	20.18±1.71	0.90-0.80
Narrow leaf-stigma color* (3:1) (13:3)	$\frac{nal\text{-}ps_2}{Nal\text{-}Ps_2}$	D-155-8xT201	73	5	1	8	87	C	32.90±7.27	0.20-0.10
Phenol reaction-stigma color* (3:1) (13:3)	$\frac{ph\text{-}ps_2}{Ph\text{-}Ps_2}$	D-155-8xT201	71	5	14	8	98	C	38.31±7.36	0.20-0.10
Purple stigma-purple hull (3:1) (3:1)	$\frac{ps_2\text{-}pr}{Ps_2\text{-}Pr}$	D-155-8xJ327	135	43	4	56	238	C	3.95±0.14	0.90-0.80
Purple leaf-narrow leaf (3:1) (3:1)	$\frac{pl\text{-}nal}{Pl\text{-}Nal}$	D-155-8x7102	159	16	17	52	244	C	13.89±1.63	0.70-0.50

Purple apiculus-dwafness (3:1) (3:1)	$\frac{CaP\text{-}d_{31}}{CAP\text{-}D_{31}}$	D-155-8x7102	182	62	62	9	315	R	38.10±3.20	0.70-0.50
Purple leaf-dwarfness (3:1) (3:1)	$\frac{pl\text{-}d_{31}}{Pl\text{-}D_{31}}$	D-155-8x7102	158	17	24	45	244	C	17.69±1.85	0.70-0.50
Purple apiculus-narrow leaf (3:1) (3:1)	$\frac{CaP\text{-}nal}{CAP\text{-}Nal}$	D-155-8x7102	176	68	62	9	315	R	36.40±3.25	0.80-0.70

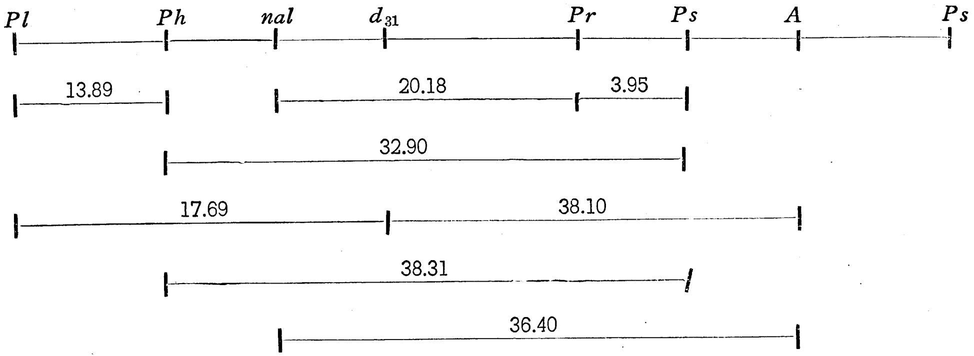
*…only under apiculus being colored 稃尖有色之情況下。

4. 矮性遺傳因子與其他性狀之連鎖關係：

在本試驗中所觀察到之各種性狀間，經獨立測定後之結果，列於表4。大部分之性狀與矮性（d_{31}）及細葉因子（lg）間無連鎖關係。但紫穎色因子（Pr）、石炭酸反應因子（Ph）、無葉舌因子（lg）及矮性因子（d_{31}）等和細葉因子間却發現有不同强度之連鎖組換值（Recombination values）。另在D-155-8×7245 之什交後代中，發現 7245 之矮性因子 dx 和密穗因子（Dn）間亦有連鎖。茲將各性狀間之連鎖情形，經利用積算法或最大近似值法計算之結果列於表 5 。

表 5 顯示出，細葉與柱頭色因子間有 32.90±7.29% 之組換值，而其他各性狀組合間之組換值分別爲：石炭酸反應與柱頭色因子間 38.31±7.36%；紫色柱頭與紫穎色因子間 3.95±0.14%；紫葉與細葉因子間 13.89±1.63%：紫色稃尖（P）與矮性因子（d_{31}）間 38.10±3.20%；紫葉與矮性間7.69±1.85% 和稃尖色與細葉因子間 36.40±3.25%等。這些因子均位於第二染色體羣上（如下圖所示）。

另外支配7245之矮性因子（dx）和 d_{31} 彼此獨立，故知爲位於不同染色體連鎖羣上。而此矮性因子和密穗因子（Dn）有 21.03±2.09 %之組換值。由此推論，此矮性因子可能屬於 Nagao 及 Takahashi 之第七染色體連鎖羣（fs-group），此點尙有待進一步之證實。



討　論

有關日本型稻及印度型稻之遺傳結構（Genetic constitution）是否相同之事，迄今未有詳確之結論。在本研究中顯示出（表２），此兩型稻之稃尖色及其他顏色性狀之遺傳現象，均可依據長尾和高橋(1956,1962) 補助因子之複對因子系統之假設來解釋。但亦發現在 D-155-8 與白米粉或蟻公包雜交組合中，其實際與理論分離化略有差異，不似 D-155-8 與中村或戰捷兩組合中，兩值適合度之高。此結果似與 F_1 植株之結實率有關。即其 F_1 植株結實率高者，實際分離比與理論分離比接近。

而其結實率低者，兩者之分離比差異大。這個差異的原因尚待更進一步之研究。

由 Nagao 和 Takahashi (1956) Takahashi (1958) 之報告得知 Nagao A-58 之稃尖着色因子型爲 $C^{B}AP$ 。在此研究中 J327 親本性狀與 Nagao A-58 相似，同時 F_2 植株稃尖色之分離比及稃尖着色情形亦和 Nagao A-58 之雜交組合相同，故其因子型亦可能爲 $C^{B}AP$。同時當 D-155-8 與 Nagao A-58 或 J327 什交時， F_1 植株稃尖呈紫色， F_2 植株則分離 3 紫色與 1 無色之比例，此表示爲一對遺傳因子分離之結果。同時在連鎖測定時，發現此稃尖色因子與細葉及矮性因子間有連鎖。由以往的研究中我們已知此兩因子是位於第 2 染色體連鎖羣上。而位於染色體上之稃尖色因子只有 A 。因此推定 D-155-8 之稃尖着色因子型 CaP 。另外在 D-155-8×T201 (或T203) 雜交組合中，兩親本稃尖均無色，而 F_1 却產生紫色，根據補助作用之原則推定，T201 和 T203 之稃尖因子型，可能爲 $c\ A\ P$，此在 F_2 植株中分離 9 紫色：7 無色之結果可得證明。而在 J302 和 J317 等雜交組合中， F_1 植株之稃尖均呈紅色，F_2 植株亦分離 9 紅色：7 無色。且其 F_1 植株之柱頭上並無顏色，因此可推定其稃尖因子型爲 $cA^{d}P$ 。同時亦可推測出 D-155-8 之 C 因子亦可能爲 C^{BP} 。

有關柱頭色之遺傳，更爲複雜，已發現之分離情形有 3：1、1：0、9：7、3：13、27：37 和 9：55等等 (Takahashi 1958 ; Hsieh 1960) 。本試驗亦均符合。但有13有色：3 無色之新分離現象。此一分離現象在本研究中暫定之解釋爲兩對遺傳因子之分離，但有三對因子參予其作用，同時其中一對且爲抑制因子。即假設 D-155-8 之柱頭色因子型爲 $Ps_1, Ps_2, I\text{-}Ps_1$, T201 之因子型則爲 $Ps_1, ps_2, i\text{-}Ps_1$。 F_1 之因子型則爲 $Ps_1\ Ps_1\ Ps_2\ ps_2\ I\text{-}Ps_1\ i\text{-}Ps_1$。由於 D-155-8 之稃尖無色，故雖然具有柱頭色分佈因子，仍無法表現出顏色。其 F_2 分離情形，如下圖所示。此外，若根據隱性突變因子之隱性抑制作用 (Recessive suppressor of a recessive mutant gene) ，亦可解釋。關於此點尚待更進一步之研究。

Ps_2	$I\text{-}Ps_1,\ Ps_1$	9 有色	13有色
	$i\text{-}Ps_1\ \ Ps_1$	3 有色	
ps_2	$I\text{-}Ps_1\ \ Ps_1$	3 無色	3 無色
	$i\text{-}Ps_1\ \ Ps_1$	1 有色	

摘　要

D-155-8 是臺中155號放射線誘變而得之突變矮稻，稃尖無色、葉細、深綠色、有葉舌、矮 (高約70cm)。謝 (1962) 將此矮性因子訂爲 d_9，Chang 和 Jodon (1963) 統一改定爲 d_{31}。在D-155-8×T201等 7 組合之分析中，得知此 D-155-8 親本稃尖和柱頭顏色之因子爲 $C^{BP}a\ P\ Ps_1\ Ps_2\ I\text{-}Ps_1$ 。同時得知，柱頭着色爲稃尖着色因子之下位，此點和 Nagao 及 Takahashi 等之報告相同。同時柱頭色之分離，較稃尖色複什。除與前人報告相同者外，並發現一新的分離現象 (13有色：3 無色) 。

至於矮性因子 (d_{31})、細葉 (nal)、石炭酸反應因子 (Ph)、無葉舌因子 (lg)、密穗因子 (Dn)、向地性 (la)、莖葉脆性 (bc)、等性狀本研究中發現均受一對遺傳因子所支配。而另在連鎖研究中發現，矮性因子 (d_{31})、紫潁色因子 (Pr)、紫色柱頭因子 (Ps_2)、石炭酸反應因子(Ph) 及無葉舌因子 (lg) 與細葉因子 (nal) 間等均有明顯的連鎖關係。且這些因子均屬於 Nagao 之第二染色體連鎖羣。但細葉因子 (nal) 却和稃尖因子 (C)、矮性因子 (7245-d)、密穗因子 (Dn)、莖葉脆性 (bc) 及向地性因子 (la) 等因子相互獨立。

THE INHERITANCE OF COLORATION AND SOME OTHER CHARACTERS OF AN INDUCED DWARF MUTANT

GENIC ANALYSIS IN RICE, X

by

S. T. Yen and S. C. Hsieh

SUMMARY

D-155-8, an X-ray induced dwarf mutant from Taichung no. 155, is measured about 70 cm in height at maturity, and the leaves being narrow and dark green in color. This strain was crossed with three gene markers of rice and five cultivated varieties. This paper, therefore, dealt mainly with the inheritance of the pigmentation and some morphological characters of those crosses.

The inheritance of dwarfness (*d*), narrow leaf (*n*al), phenol reaction (*P*h), liguleleslessness (*l*g), dense panicle (*D*n), laziness (*l*a), and brittle culm (*bc*) characters was controlled by single gene, respectively. These results were consistent to earlier workers (Nagao 1951, Nagao and Takahashi 1960, Hsieh 1962). The inheritance of pigmentation on apiculus, four out of six crosses, are controlled by two complementary genes, the others are controlled by single gene. Same genes controlled the inheritance of stigma coloration in most cases, but a new mode of segregation ratio of 13 colored to 3 colorless on stigma coloration was also observed and dissussecd in this study. Therefore, the genotype of D-155-8 on apiculus and stigma coloration was postulated as $CCaaPPPs_1Ps_1Ps_2Ps_2I\text{-}Ps_1$ $I\text{-}Ps_1$.

The linkage relationships between combined characters was estimated. The recombination value was 3.95±0.14% between purple stigma and purple hull, and that of 38.31±7.36% between phenol reaction and stigma coloration. The other linkage intensities between combined characters were ranged from 13.89% to 38.10% in six other pairs, as shown in Table 5.

LITERATURE CITED

1. Chang, T. T. and N. E. Jodon. 1963. Monitoring of gene symbols in rice. Internl. Rice Comm. News Letter. XLL(4):19-29.
2. Hsieh, S. C. 1960. Coloration genes and inheritance of other characters in rice (Genic analysis in rice I). J. of Agri. Res. 9(2):1-13.
3. ——— 1962. Inheritance of mutations induced by irradiations in rice. Bot. Bull. of Academia Sinica 3(2):151-162.
4. ——— and T. M. Chang. 1962. Genic analysis for purple pericarps and other characters in rice. J. of the Agri. Assoc of China. New Series. 40:27-39.
5. Mohamed, A. H., G. S. Mallah, and A. S. Hanna. 1960. Linkage studies between some morphological characters in rice. Alexandria J. of Agri. Res. 8(2):9-21.
6. Nagao, S. 1951. Genic analysis and linkage relationship of characters in rice. Advances in Genetics 4:181-212.

7. ························and M. Takahashi 1956. Some chemical aspects on anthocyanın coloration caused by C and Sp (A) allelomorphic series of genes (Genetical studies on rice plant XX) Bot. Magazine 69(820-821):430-434.

8. ···1960. Preliminary report of twevele linkage groups in Japanese rice. The J. of the Facult. of Agri. Hokkaido U. 51:288-298.

9. ···1962. Mode of inheritance and causual genes for one type of anthocyanin color character in foreign rice varieties. (Genetical study on rice plant XXVL). The J. of the Fecult. of Agri. Hokkaido U. 52(1):20-50.

10. Takahashi, M. 1958. Genes for localization of anthocyanin pigment in stigma. The Japanese J. of Breed. 8(3):142-148.

11. U. S. Dept. of Agri. 1963. Rice gene symbolization and linkage group. ARS 34-28. PP 56.

12. Yen, S. T., M. H. Lin and S. C. Hsieh. 1968. Linkage relations of another induced dwafness gene d_{31}. Bot. Bull. of Academia Sinica 9(N.S): 69-74.

利用 Partitioning method 分析水稻株高之遺傳

嚴　盛　添

我們均已熟知，株高是數量性狀之一。而數量性狀的遺傳基礎與質量性狀者相同。故數量性狀亦可表現出不同程度之顯性，因子間作用及連鎖等。只不過是數量性狀因子，受環境之影響大，單一因子之作用小，故常表現出連續性的分佈。但亦並非所有連續性的分佈，就必須是受很多對遺傳因子所支配。有時只要數對因子加上環境的作用就可表現出連續性的分佈。Mather (1949) 曾替此數量因子下一定義說，此作用因子爲一遺傳物質的最小單位，但可被統計遺傳的方法分析出來。它可能是一羣緊連著的因子，或最低限度是單一因子。

迄今爲止，數量性狀遺傳之分析方法很多。但此地所應用的分析方法是首由 Powers (1950, 1951, 1955), Powers, Locke 和 Garrett (1950), Leonard, Mann 和 Powers (1957) 所用之Partitioning method of genetic analysis applied to quantitative characters。他們首先用於蕃茄果實之重量、開花期、子室數等之分析。然後亦曾應用於大麥株高之遺傳分析。Mohamed 和 Hanna 則首先用於分析水稻株高 (1964) 及穗長 (1965) 之遺傳。筆者個人認爲此亦是一很好的分析方法之一。乃利用本室所得植株高度之資料，應用此方法，介紹如下。

材料與方法

利用本室保存之嘉農242放射線誘變矮稻 D-242-2與由中興大學所育成之臺中65號 isogenic line，IG-65-4 雜交。F_1 種子於1964年獲得。接著即繁殖 F_2 種子。F_2植株 300 株，單本植種於田間，依一般之栽培方法管理之。於成熟期自地面至最高植株之穗頂，量取其每一植株之高度。同時亦量取兩親本之高度。D-242-2 高約 40cm，而 IG-65-4 高約 103cm。

控制此株高遺傳之因子對數、因子作用情形等，則採用 partitioning method of genetic analysis (Powers 1950, 1951, 1955; Powers, Locke 和 Garrett 1950; Leonard, Mann 和 Powers 1957) 方法來分析及解釋。玆將試驗結果說明如下。

試驗結果

親本、F_1 和 F_2 植株所量得之株高分佈、平均值及標準機差，列於表一。在此資料中，假如其變異性是算術性 (Arithemetic scale)，則其理論 F_1 株高平均值應爲 71.2cm。另一方面，如爲幾何性者 (Geometric scale)，其理論 F_1 株高平均應爲 63.8cm。但我們實際獲得之 F_1 株高平均爲 104cm 相差非常大，故其因子作用並不隨上述兩個 scale 中之任何一個。

表1.　親本、F_1、F_2 族羣之株高頻度分佈

Table 1. Observed frequency distributions for plant height of parents, F_1 and F_2 populations

族羣 Population	頻度分佈數（各組上限） Frequency distribution in number "upper limits of class"														總數 Total	平均 Mean cm	S
	30	35	40	45	50	……	85	90	95	100	105	110	115	120			
D-242-2		1	5	4											10	39.6	2.63
F_1											2				2	104.0	1.42
F_2	3	6	31	24	10		1	2	1	17	55	78	54	14	300	89.97	32.61
IG-65-4										3	5	0	2		10	102.7	5.10

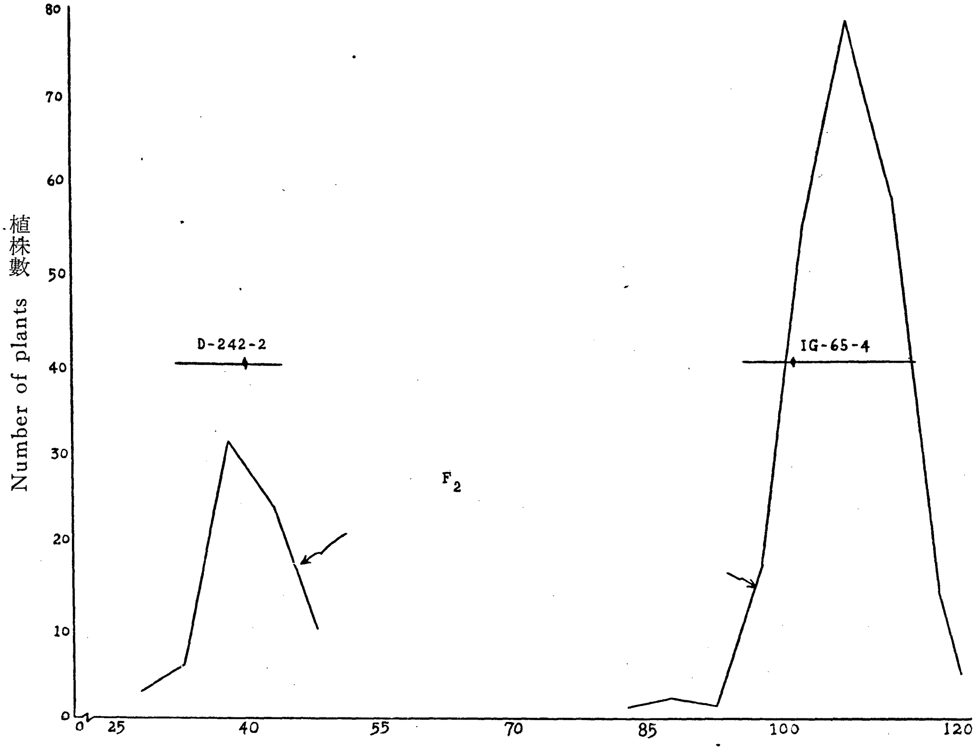
表2. 親本及F_2株高之百分率頻度分佈

Table 2. Frequency distributions of observed data of parents and F_2 populations expressed as percentages

族羣 Population	各組上限 Upper class limit														總數 Total
	30	35	40	45	50	……	85	90	95	100	105	110	115	120	
D-242-2		10.00	50.00	40.00											10
F_2	1.00	2.00	10.33	8.00	3.33		0.33	0.67	0.33	5.67	18.33	26.00	19.34	4.67	300
IG-65-4										30.00	50.00	0	20.00		10

親本間之差異如前所述，D-242-2 之株高平均爲 39.6cm, IG-65-4 爲 102.7cm 兩者相差 63.1cm 達極顯著標準。但高的親本 IG-65-4 之高度與 F_1 植株高度104公分相差不到 2cm 其差異不顯著。由此可得證明表現型顯性和遺傳顯性均存在於此雜交組合中。同時，因子內或因子間之相互作用亦均存在。因此任何 scale 都無法解釋其遺傳變異。但根據 Powers (1950) 之理論，在分析此種資料時，必須先消除遺傳之變異，其消除的方法爲設立每一族羣之因子型。本試驗之分析方法即根據此種理論來進行。

因爲我們是用算術之規格來記錄資料，故首先須確定變異性是否與常態分佈配合 (Leonard *et al*, 1957) 。在本試驗中因兩親及 F_1 族羣，其分佈無法滿足常態性測定之要求。而 F_2 族羣個體分佈，則又非常明顯地分成不連續之兩個分佈。故雖未行常態性測定，亦可知其必非常態性。



Plant Height (cm) 株高

圖1. 親本及 F_2 植株之平均及分佈。水平線表示親本之範圍，圓圈表示平均。

Fig. 1. Distribution and means of parents and F_2 plants by height classes in cross of IG-65-4 by D-242-2. Solid horizontal lines show the range of parents about the means.

由表1、表2、和圖1中均可明顯地看出，F_2 頻度分佈是 dimodal。第一個 mode 發生在 40cm 組中，頻度佔10.33％，此 mode 與矮親本 D-242-2 之 mode 相同。而另一 mode 發生於 110cm 組中頻度爲26.0％。假若自 50cm 組以下之各組頻度加起來時，可得24.66％，約佔全分離族羣之 1／4，此結果或可表示是一對因子支配此植株高度之遺傳。

但事實上 110cm 組之 mode 與高親本之 mode 不相符合，因此表示，至少另有一對以上之因子參予其作用。於是最簡單之假設，即是兩對因子支配著此株高之差異。在此假設下，如再仔細比較 F_2 族羣之分佈與雙親族羣之分佈。我們就可假設 D-242-2 之因子型爲 aaBB ，而IG-65-4 因子型則爲 AAbb.

前面已得知，表現型之顯性作用是存在的，故當植株屬於 Aabb 因子型時，其外表高度亦將與 AAbb 者同。故在 F_2 族羣中與親本 IG-65-4 同組者將佔18.75 ％。同理得知 F_2 植株中與親本 D-242-2 同組（Classes）者，亦佔18.75％。此數是根據兩對因子分離時，其 F_2 後代之分離比9/16，3/16，3/16和1/16而來。

根據上述理論，任何 F_2 頻度分佈均可根據兩親本系統分佈之基礎被劃分開來（如表3）。在表3最後一欄所列之理論百分率，加上兩親本觀察所得之頻度分佈，均可被用來分別估計植株具有 AAbb 和 Aabb 或 aaBB 和 aaBb 之理論頻度分佈。而在表3第二行及第三行所列之數值，即爲植株具有該所定因子型之理論頻度分佈。將此數值自觀察之 F_2 族羣百分率中減去之後，所剩下之頻度分佈是屬於植株頻具有 AABB, AABb, AaBB, AaBb 及 aabb 等因子型者。

表3. 根據雙親之頻度分佈基礎所分成之F_2族羣頻度表

Table 3. Partitioning the frequency distribution of the F_2 Population on the basis of frequeney distributions of the two parents

族羣 Population	各組上限 Upper class limit														理論F_2百分率 Theoretical percentages F_2
	30	35	40	45	50	……	85	90	95	100	105	110	115	120	
F_2 (aabb … AABB)	1.00	2.00	10.33	8.00	3.33		0.33	0.67	0.33	5.67	18.33	26.00	19.34	4.67	100.00
D-242-2 (aaBB+ aaBb)		1.88	9.37	7.50											18.75
IG-65-4 (AAbb+ Aabb)										5.63	9.37	0	3.75		18.75
Balance (AABB+ AABb+ AaBB+ AaBb+ aabb)	1.00	0.12	0.96	0.50	3.33		0.33	0.67	0.33	0.04	8.96	26.00	15.59	4.67	62.50

事實上其頻度分佈（表3最下1行）仍是分兩羣，同時各羣之內，亦稍有不同程度的兩個峰。如矮株羣之 1.00（30-class）和 3.33（50-class）及高株羣之 0.67（90-class）和 26.00（110-class）。此表示 Aa 和 Bb 因子對之間有不同程度之作用，此亦表示有完全的因子顯性作用。下一步利用 Leonard 等三氏（1957）所列述之方法求各因子型之平均及標準機差。即利用$\frac{\bar{X}p_1-\bar{X}p_2}{S^2p_1-S^2p_2}$公式，再依其各因子型平均高度，與親本型之高度間的比例關係，求出各新因子型組之理論變方，其結果列於表4。在此表中，其因子型的平均的理論標準機差（Theoretical standard errors of the means of genotypes）與 F_2 族羣是由因子型所組成之假設相同，每一因子型之分佈，均在其平均附近變化。

表4. 各因子型組之理論平均，變方及標準機差等

Table 4. Statistical constants and theoretical values for estimation of theoretical frequency distribution

因子型組 Genotype groups	$\bar{x}$±S.E.	S^2	S	理論數 Theoretical number	理論百分率 Theoretical percent
AABB+AABb+AaBB+AaBb	108.88±0.41	27.87	5.28	168.75	56.25
AAbb+Aabb (P₁)	102.70±0.68	26.01	5.10	56.25	18.75
aaBB+aaBb (P₂)	39.60±0.35	6.93	2.63	56.25	18.75
aabb	42.26±0.64	7.73	2.78	18.75	6.25

在表5中，其九個 F_2 之因子型的四組理論頻度分佈是利用 Powers 等 (1950) 所設計之方法計算出來的。首先算出其理論百分率頻度，再乘以觀測族羣總數就可算出其理論的 F_2 頻度分佈。有 F_2 族羣觀察頻度分佈與理論頻度分佈，就可利用 X^2 一法行均質性測定，示如表6。其 X^2 值爲3.24，其自由度則爲5，機率介於0.70—0.50之間。表示兩者非常符合，此證實了兩親本間株高之差異是受兩對因子所支配。

表5. 用百分率表示之理論F_2頻度分佈估計表

Table 5. Estimation of the theoretical frequency distributions of the F_2 population expressed as percentages

因子型 Genotypes	各組上限 Upper class limit														理論百分率 Theoretical percentages
	35	40	45	50	55	……	90	95	100	105	110	115	120	125	
AABB+AABb+AaBB+AaBb								0.43	4.22	18.62	35.05	29.38	10.56	1.74	56.25
AAbb (P₁)							0.64	5.91	23.36	37.55	25.00	6.84	0.80		18.75
aaBB+(P₂)	4.01	51.95	42.02	2.02											18.75
aabb	0.45	20.45	62.75	16.08	0.27										6.25
Theoretical F_2 population	0.78	11.02	11.80	1.38			0.12	1.47	6.74	17.51	24.40	17.81	6.09	2.98	100.00

表6. X^2-測定觀測及理論F_2頻度分佈間之均質性表

Table 6. Chi-square test for homogeneity between the observed and theoretical F_2 frequency distributions

族羣 Population	各組上限 Upper class center									植株數 Number of plants
	37.5	42.5	47.5	……	97.5	102.5	107.5	112.5	117.5	
觀測值 Observed	40	34			21	55	78	58	14	300
計算值 Calculated	37.5	36.5			23.0	54.0	76.0	55.5	17.5	300
理論值 Theoretical	35	39			25	53	74	53	21	300

X^2=3.24　　df=5　　p=0.70–0.50

最後利用 Leonard 等（1957）之方法，由其各因子平均値及標準機差計算其各因子作用之大小及相互作用。

(a) A-a 因子對之作用

第一次估計：102.70±0.68－42.26±0.64＝60.44±0.95

第二次估計：108.88±0.41－39.60±0.35＝69.28±0.56

(b) B-b 因子對之作用

第一次估計：39.60±0.35－42.26±0.64＝－2.66±0.62

第二次估計：108.88±0.41－102.70±0.68＝6.18±0.69

由此估値中，可明顯地看出來，A-a 因子對較 B-b 因子對有大約强10倍的作用。其次再測定其相互作用。

a) A-a 作用因子對　60.44±0.95－69.28±0.56＝－8.84±0.96

b) B-b 作用因子對　(－2.66±0.62) －6.18±0.69＝－8.84±0.96

由此可看出來此兩值是相同的。

討　　論

此 Partitioning method of genetic analysis 是基於可將任何分離族羣中之頻度分佈分成其因子型成分。同時其遺傳假說之有效性可利用其理論與實際平均，頻度分佈及變方等間之比較測定來達成（Powers 等1950）。

由 Leonard, Mann 和 Powers（1957)之分析方法得知，此兩親系統 IG-65-4 和 D-242-2，株高之差異，是受兩對遺傳因子之支配。而 IG-65-4 和 D-242-2 之遺傳結構（因子型）分別訂爲 AAbb 和 aaBB。同時亦發現 A-a 因子對，在株高上之影響力，大約較 B-b 因子對之10倍以上。這結果證實了，數量因子間亦有顯性之作用。

而應用此方法，亦非沒有缺點，主要的是，當因子對數增多時，計算繁什，分析困難，其眞實性亦降低。但此點，並非只此方法有此缺點，其他許多之分析方法，均有同樣的缺憾。另一方面，每一族羣之個體，都需相當多。但此報告中之兩親、F_1 及 F_2 等族羣，其個體數均不太多。因此其結論之有效性，亦可能相對的減少些。但這也是由於水稻在什交上比較困難之限制，無法像異交作物那様容易獲得大量之什交後代。同時此報告之目的，亦以介紹此分析方法爲主，實際的結論爲輔。另外，在將來的分析時，亦應增加有回交系統和 F_3 以後之世代。有了這些族羣，及增加每一族羣的個體數時，其結論的精確性便可大大的增加。

摘　　要

在臺中65號之 isogenic line，IG-65-4 與嘉農 242 號之突變矮稻，D-242-2（其植株高度分別爲 103cm 和 40cm）之雜交後代中。利用 partitioning method of genetic analysis (Powers,1950, 1951, 1955; Powers，Leocke 和 Garrett, 1950; Leonard， Mann 和 Powers, 1957) 分析。其結果得知 IG-65-4 的因子型爲 AAbb，D-242-2 的因子型爲 aaBB，其株高的差異是受兩對因子所控制。且其中之一對因子（A）的作用較另一對因子（B）的作用約大10倍。

STUDY OF PLANT HEIGHT INHERITANCE OF RICE BY PARTITIONING METHOD OF GENETIC ANALYSIS

By

Sheng-tian Yen

Summary

An isogenic line of Taichung no. 65, IG-65-4, was crossed with an induced dwarf mutant from Chianung 242, D-242-2 which measured about 103 cm and 40 cm respectively. Two effective factor pairs (genes) differentiating the plant height between these two parents were estimated by the partitioning method of genetic analysis of Powers and his coworkers. Moreover, one of the effective factor pairs is estimated about 10 times more effective than the other.

References Cited

1. Leonard, W. H., H. O. Mann, and L. Powers. 1957: Partitioning method of genetic analysis applied to plant height inheritance in Barley. Colorado Agr. and Mechan. College, Agr, Exptl. Sta. Tech. Bull. no. 60. pp 24.
2. Mohamed, A. H. and A. S. Hanna. 1964: Inheritance of quantitative characters in rice. I. Estimation of the number of effective factor pairs controlling plant height. Genet. 49:81-93.
3. ______________________. 1965: Inheritance of quantitative characters in rice. II. Inheritance of panicle length. Canadian J. of Genet. and Cytology 7 (3):406-417.
4. Powers, L. 1950: Determining scale and the use of transformations in studies on weight per locule of tomato fruit. Biometrics 6 (2):145-163.
5. ______. 1951: Gene analysis by the partitioning method when interactions of genes are involved. The Botanical Gazette 113(1): 1-23.
6. ______, 1955: Components of variance method and partitioning method of genetic analysis applied to weight per fruit of tomato hybrid and parental populations. U. S. Dept. of Agr. Tech. Bull. no. 1131. pp 64.
7. ______, L. F. Locke, and J. C. Garrett. 1950: Partitioning method of genetic analysis applied to quantitative characters of tomato crosses. U. S. Dept. of Agr. Tech. Bull. no. 998. pp 56.

WEED CONTROL EFFECT OF SOME HERBICIDES IN PADDY FIELD

W. L. Chang*

Interest in controlling weeds in paddy field by chemicals has greatly increased in recent years. During the past years, considerable amount of time has been devoted to screening herbicides for use in rice, and the Department of Agriculture and Forestry of Taiwan Provincial Government has recommended several herbicides for commercial use in the nursery and in the paddy field. However, weeding in paddy fields is still done largely by hand in Taiwan presumably because most chemicals now available are either too expensive or imperfect in the control of weeds. As industrial development of this island is progressing very rapidly, the supply of farm labor is bound to decrease in the coming days, and hand weeding may eventually be replaced by the chemical in the future. In order to meet the future demand of rice growers, the Chiayi Agricultural Experiment Station has been closely cooperating with the International Rice Research Institute in the testing of new herbicides with the purpose of finding out a more economical and effective weed control method acceptable to farmers. This paper summurizes part of the results obtained from the second cooperative experiment conducted in the second crop of 1967.

MATERIALS AND METHODS

The experiment was conducted in the second crop (wet season) of 1967 at the Wan-tien-li Farm of the Chiayi Agricultural Experiment Station. Soil of the experimental plots was sandy loam and pH, organic matter, available P_2O_5, and available K_2O of the surface soil were 5.1, 2.46%, 513 kg, and 60 kg per ha, respectively. Chianung 242, a typical panicle weight of Japonica rice variety was subjected to 16 weed control treatments as listed in Table 1. Name, formulation, and source of the herbicides used in this experiment are also given in Table 2.

Table 1. Treatments of chemical weed control experiment.

Treatment	Active rate (kg/ha)	Timing
1. Hand weeding (HW)	3 times	10, 17, and 25 days after transplanting.
2. MCPA+HW	0.8+1 HW	MCPA at 15 days, and HW, 25 days after transplanting.
3. Pyridinol	0.2	1 day befor transplanting.
4. Pyridinol+MCPA	0.2+0.8	As above; MCPA, 25 days after transplanting.
5. Molinate	3.0	Grass weeds at 1-2 leaf stage or 7 days after transplanting.

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6. Molinate+MCPA	3.0+0.8	As above; MCPA, 25 days after transplanting.
7. NPE	2.0	3 days after transplanting。
8. NPE+MCPA	2.0+0.8	As above; MCPA, 25 days after transplanting.
9. KN_3	5.0	At 2-3 leaf stage of grass weeds or 9 days after transplanting.
10. KN_3+MCPA	5.0+0.8	As above; MCPA 25 days after transplanting。
11. Trifluralin	1.0	6 days after transplanting.
12. Trifluralin+MCPA	1.0+0.8	As above; MCPA 25 days after transplanting。
13. EPTC/2,4-D	3.0	3 days after transplanting.
14. Dichlobenil	1.5	3 days after transplanting.
15. Dichlobenil+MCPA	1.5+0.8	As above; MCPA, 25 days after transplanting.
16. No weeding	—	—

Table 2. Herbicides used in the test.

Name of herbicide		Formultion	Source
Chemical	Trade		
MCPA	Agroxone-4	48% EC	Imperial Chem. Ind.
Pyridinol	Daxtron M-2901	19.3% EC	Dow Chem. Co.
Molinate	Ordram 6-E	71% EC	Stauffer Chem. Co.
NPE	TOK	7% G	Rohm & Hass Co.
KN_3	Potassium Azide	9% G	Pittsburgh Plate Glass Co.
Trifluralin	Treflan	44.5% EC	Elanco Prod. Co.
EPTC/2,4-D	Knoxweed 42	(46.9% Eptan+35. 4% 2.4-D)EC	Stauffer Chem. Co.
Dichlobenil	Casoron 133	50% WP	Phillips-Duphar

The design of the experiment was a randomized complete block with 4 replications. The plot was 3 x 4 m in size from which 2.5 x 4 m or 10 m^2 was harvested for yield determination。 The plant spacing was 25 by 20 cm with approximately 5 seedlings being transplanted at each hill. Ammonium sulphate, calcium superphosphate, and potassium sulphate were used as carriers of N, P_2O_5, and K_2O which were applied at the rate of 80, 40, and 40 kg per ha, respectively.

In order to insure a uniform and dense stand of weeds, 1.5 kg per ha of *Echinochloa crusgalli*, 0.5 kg per ha of *Monochoria vaginalis*, and 1.0 kg per ha of *Cyperus difformis* seeds were broadcast on the plots. Herbicides were applied to a shallow (1-3 cm) flood of water either by spraying or by broadcasting. Levees were made arround the plots to prevent the interflow of herbicides between neighbour plots.

Visual scores of weed control and rice toxicity were taken weekly started from one week

after the application of chemicals based on an arbitrary 0-4 scale devised by the author. Class 0 indicates whether complete control of weeds or no toxicity to rice plant and Class 4, no control of weeds or heaviest toxicity. Dry weed weight per plot was also recorded at the time of harvesting. Plant height and number of tillers per hill were measured once in every 20 days. Grain yield, components of yield, and other related agronomic traits were also recorded for the analysis of variance.

The weather in the early stage of rice growth was hot and rainy but a cool, dry and sunny weather prevailed during the late growing stage. Typhoon did not hit the island during the period of the experiment. The climatic data of wet season crop are presented in Table 3.

Table 3. Climatic data of the Chiayi Agricultural Experiment Station during the period of the experiment.

Ten-day Period		Rainfall amount (mm)	Number of rainy days	Number of sunshine hours	Relative humidity (%)	Temperature (°C)		
						Maximum	Mininum	Mean
Aug.	1-10	280.9	7	42.7	66	32.3	25.2	29.8
	11-20	82.9	5	22.0	70	32.2	25.3	28.8
	21-31	176.0	4	31.6	71	32.3	26.1	29.2
Sept.	1-10	62.1	6	45.1	71	31.8	25.4	28.7
	11-20	0	0	47.3	69	30.3	22.8	26.6
	21-30	9.6	2	34.0	75	29.5	22.1	25.9
Oct.	1-10	0	0	41.6	65	29.3	20.7	25.0
	11-20	2.3	1	24.9	70	28.5	21.1	24.8
	21-31	0	0	49.0	63	27.5	18.0	22.8
Nov.	1-10	7.5	2	42.7	73	28.2	20.0	24.1

RESULTS AND DISCUSSION

Effect of Herbicides on the Control of Weeds and the Toxicity of Rice.

The infestation of weeds in the experimental plots at the early stage of rice growth was mostly the broad leaves. However, the grasses developed rapidly and became the predominant weeds in some plots at the later stages. The sedges occupied only a small fraction of the total weed population. The most common broadleaves in the experimental plots were *Monochoria vaginalis, Marsilea quadrifolia, Lemma paucicostata,* and *Spirodela polyrhiza.* The grasses were predominately *Echinochloa* spp. and *Paspalum scrobiculatum,* whereas *Cyperus differmis* anb *C. iria* were the predominant sedges.

The visual scores of weed control and rice toxicity as well as dried weight of weeds are presented in Table 4. MCPA applied at 15 days after transplanting killed most of the broadleaved weeds and sedges but failed to control grassy weeds. Since broadleaves were the most predominant weeds in the experimental plots and weeds not controlled by MCPA

were removed by handweeding, treatment 2 resulted in a good control of weeds with visual scores of less than 2. The combination of MCPA followed by handweeding was also rated as one of the best treatment at the International Rice Research Institute (Moomaw *et al.*, 1966).

Table 4. Effect of herbicides on weed control, rice toxicity, and dry weed weight.

Treatment	Weed control score					Rice toxicity score					Dry weed weight at hervest (g/10 m²)			
	Weeks after application 1	2	3	4	5	Weeks after application 1	2	3	4	5	Grasses	Broad-leaves	Sedges	Total
1	1.0	1.0	1.0	1.0	1.0	0	0	0	0	0	205	160	–	365
2	1.9	1.3	1.5	—	—	0	0	0	–	–	371	153	1	525
3	2.7	3.5	4.0	4.0	4.0	2.0	1.0	0	0	0	610	1,040	9	1,659
4	2.8	3.5	3.5	1.5	1.8	2.0	1.0	0	1.0	2.0	851	143	–	994
5	3.4	4.0	4.0	4.0	—	0	0	0	0	–	661	849	1	1,511
6	3.8	4.0	1.5	1.5	—	0	0	1.6	2.1	–	811	103	–	914
7	1.0	1.0	1.3	1.9	2.5	1.0	0.5	0	0	0	1,540	189	2	1,731
8	1.0	1.0	1.3	1.3	1.3	1.0	0.5	0	1.0	2.0	1,034	105	–	1,139
9	1.3	1.3	1.3	1.5	—	0	0	0	0	–	1,255	108	–	1,363
10	1.3	1.3	1.3	1.5	—	0	0	1.0	2.0	–	1,248	245	1	1,494
11	1.5	2.2	2.8	3.1	–	0	0	0	0	–	1,063	432	1	1,496
12	1.5	2.0	1.3	1.0	–	0	0	1.0	2.0	–	404	89	–	493
13	1.0	1.0	1.8	2.7	3.2	1.0	1.0	0	0	0	728	438	23	1,189
14	1.0	1.0	1.5	2.3	2.6	0	0	0	0	0	1,092	494	–	1,586
15	1.0	1.3	1.5	1.5	1.5	0	0	0	1.3	2.2	696	112	–	808
16	4.0	4.0	4.0	4.0	4.0	0	0	0	0	0	1,626	1,253	–	2,879

Treatments with Pyridinol and Molinate applied alone gave poor control of weeds showing that these two chemicals could not control broadleaves which were the major weeds of the experimental plots. However, a good weed control was obtained when these chemicals were followed by an application of MCPA at 25 days after transplanting. Although Pyridinol and Molinate performed very poorly in this experiment, these two chemicals have been frequently rated by other workers as the most effective weed killers. Tang and Tsai (1967) reported that Pyridinol applied 10 days after transplanting at the rate of 0.25 kg per ha gave a good control of both grassy and broadleaved weeds. Molinate was found to be very effective in controlling various weeds in general and barnyardgrass in particular (Tang and Wu, 1965 a, b). Good control of barnyardgrass of Molinate was also observed in experiments in Califormia and Arkansas (Smith and Shaw, 1965). Moomaw (1967) also reported that Pyridinol and Molinate were among the few best chemicals which were superior or equal to the handweeding or to the recommended practice of using 2,4-D (or MCPA) before

handweeding. Apparently, method of application and the infestation of weeds can greatly affect the effectiveness of these two chemicals.

NPE and Dichlobenil controlled weeds very effectively. The plots of these two treatments were as clean as those of the handweeded check. However, the effect of these two chemicals lasted for only about 3 weeks and the infestation of weeds became serious in the fourth week after the application of these chemicals. Thus, an application of MCPA at 25 days after transplanting was effective in controlling these newly emerged weeds. Good weed control of Dichlobenil was also found in the previous experiment (Chang, 1965). At present, NPE and Dichlobenil are among the herbicides recommended for use in rice by the government in Taiwan.

KN_3 was able to maintain a good weed control for approximately 4 weeks after its application. KN_3 applied alone and with combination of MCPA gave the same visual scores of weed control, indicating that KN_3 was very effective in controlling broadleaved weeds and, under the condition of this experiment, a follow-up application of MCPA appeared unnecessary. Tang and Tsai (1967) reported that KN_3 controlled both grassy and broadleaved weeds in their experiment. It was also effective for the control of some common aquatic weeds in rice when applied as post-emergence treatment in the United States (IRC Report, 1967).

EPTC/2,4-D showed a good control of weeds, but its effect lasted for only two weeks, when it was applied alone. Trifluralin gave only moderate control of weeds, indicating that it could not kill broadleaved weeds completely. It was found that Triflaralin followed by an application of MCPA at 25 days after transplanting reduced considerably the visual scores of weed control. Tang and Tsai (1967) also observed that Trifluralin gave good control of grassy weeds but it controlled poorly of broadleaved ones. It appears that, Trifluralin may be unacceptable in areas where broadleaved weeds are usually a mojor problem.

Visual scores of rice toxicity in Table 4 shows that Pyridinol, NPE, EPTC/2,4-D, and the late application of MCPA were quite toxic to rice, whereas no toxicity was detected for Molinate, KN_3, Trifluralin, Dichlobenil, and the early application of MCPA. Pyridinol caused chlorosis of rice seedlings and leaf blades turned white when they were seriously injured. A serious injury of Pyridinol was also reported by Tang and Tsai (1967). The submerged leaves of rice seedlings were completely destroyed by NPE, indicating that the paddy field should be flooded with a shallow water at the time of NPE application, if the occurrence of its toxicity is to be prevented. The phytotoxicity of EPTC/2,4-D was manifested in stunting growth and yellowish leaves of rice seedlings. The late application of MCPA caused outspreading of tillers and drooping of leaves. However, the injuries caused by these chemicals did not result in a complete kill of rice plants and they were found to recover within 2 weeks.

Dry weed weight measured at the time of harvesting, indicated that grasses and broadleaves comprised the majority of the final product of weeds and, sedges occupied only a small fraction of the total weight. *Paspalum scrobiculatum* which was only a minor weed at the early stage of rice growth grew vigorously and eventually dominated the weed population at the late stage of rice growth. Thus, weed control rating at the early stage of rice

growth did not agree with the dry weight of grassy weeds. However, dry weight of broad-leaved weeds was generally in parallel with weed control score, indicating that good weed control treatments generally produced small amount of weeds. The control of *Paspalum scrobiculatum* appears necessary in the area where it is potentially an important weed of the paddy field.

From the standpoint of weed control and rice toxicity, an application of MCPA at 15 days after transplanting followed by a handweeding appears to be an effective weed control method for transplanted rice as suggested by Moomaw *et. al.*, (1966). It is also the most practical one because MCPA is the cheapest chemical now commercially available. KN_3 may be an ideal chemical to replace NPE if the cost of KN_3 is lower than NPE. At present, an application of NPE costs about NT$ 900 or US$ 22.5 per ha and farmers consider it too expensive to accept, even though it is highly effective. It is also suggested that NPE and Dichlobenil followed by MCPA may control weeds more effectively than the single application of NPE and Dichlobenil now recommended for use in Taiwan. Since late application of MCPA was toxic to rice, more research will be needed regarding the time or rate of MCPA application. Tang and Tsai (1967) suggested that the active rate of MCPA should not exceed 0.2 kg per ha.

Effect of Herbicides on the Growth of Rice.

Plant height and number of tillers per hill were measured every 20 days to indicate the growth of rice plants. Figure 1 shows that plant height at 20 days after transplanting did not differ greatly among treatments, suggesting that application of chemicals did not

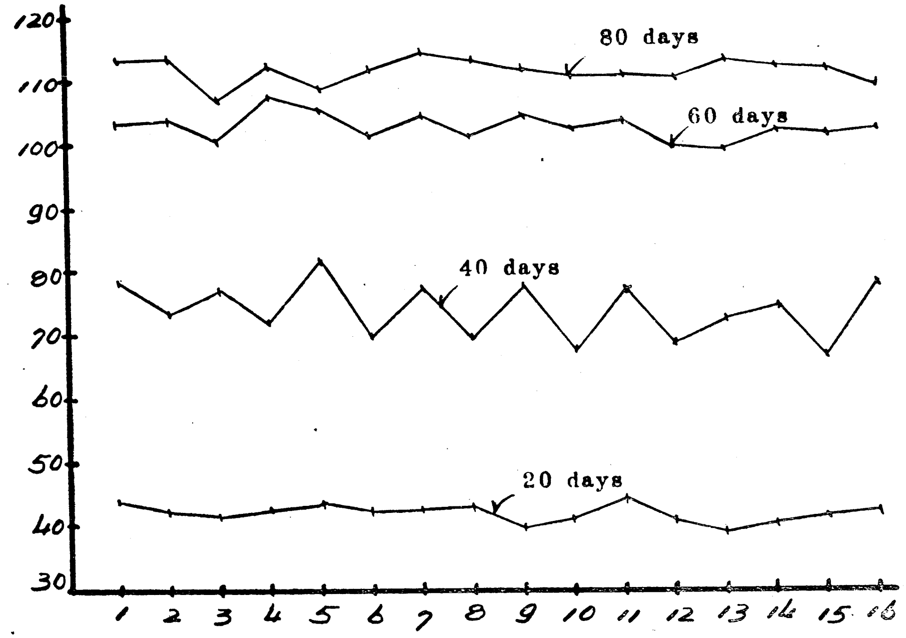

Figure 1. Effect of herbicides on plant height at different stages of growth.

affect plant height. Plant height was shorter in the treatments with late application of MCPA when it was measured at 40 days, indicating that MCPA applied at 25 days after transplanting was highly toxic to rice plants. However, the growth of rice plant recovered quite rapidly and at 60 days after transplanting, the toxicity of MCPA disappeared completely. Weed competition with rice was reflected on plant height at 60 and 80 days after transplanting. As a result, treatments with poor weed control were generally associated with shorter plant height.

Figure 2 shows that number of tillers per hill at 20 days after transplanting were smaller in the treatments of NPE and EPTC/2,4-D, showing that phytotoxicity of these chemicals was manifested in the reduction of tillers. However, number of tillers per hill was not affected by the late application of MCPA. Poor control of weeds also reduced number of tillers per hill at 60 and 80 days after transplanting, suggesting that weed competition with rice was most serious in the later stages of rice growth.

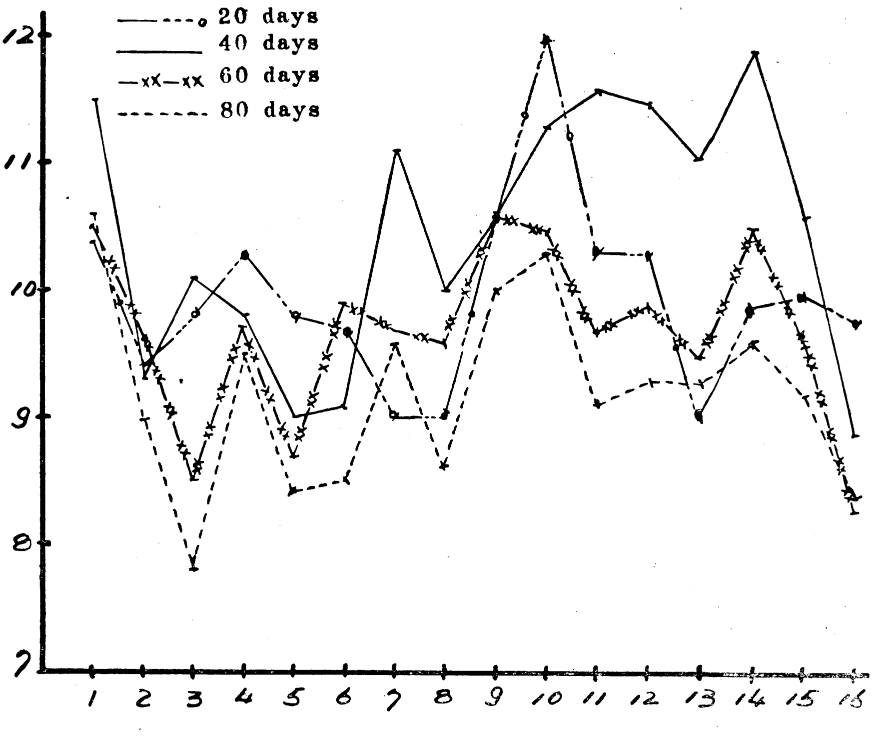

Figure 2. Effect of herbicides on number of tillers per hill at different stages of growth.

Effect of Herbicides on Grain Yield, Components of Yield, and Other Agronomic Characters of Rice.

Growing conditions during the period of rice growth were rather good but grain yield was slightly affected by the injury caused by plant hopper about one week before harvest-

ing. Weeded check, Pyridinol+MCPA, Dichlobenil+MCPA, Dichlobenil, and KN3+MCPA generally produced higher yields whereas Pyridinol, non-weeded check, and Molinate, the lowest. Weeded check produced 926 kg per ha or 30.5% more grain yield than non-weeded check, a difference greatly exceeding the 1% level of probability. Shaw and Danielson (1961) also reported that weed competition reduced yield production by 37.5%. The high yield of Dichlobenil was also obtained in the previous experiment (Chang, 1965). Weeded check outyielded all treatments, indicating that most chemicals or chemical combinations tested in this experiment were more or less harmful to the productivity of rice. It was observed that herbicides which were followed by MCPA generally gave higher yields than those applied alone, indicating that an additional application of MCPA contributed greatly to the increase of yield. The low yields of Pyridinol and Molinate may be largely attributable to severe competition of weeds.

Table 5 shows that number of panicles per hill and numbcr of grains per panicle were significantly affected by the treatments, whereas 100-garin weight was not affected. Difference among treatments in number of grains per panicle was greater than that of number of panicles per hill, suggesting that the former was more susceptible to weed competition than the latter. It was found that treatments with higher grain yield were generally associated with more panicles per hill and/or more grains per paincle, indicating that the increase in grain yield was caused largely by these two components.

Table 5. Effect of herbicides on grain yield, components of grain yield and some agronomic characters of rice.

Treatment	Grain yield (kg/ha)	Number of Panicles Per hill	Number of grains per panicle	Weight of 100 grains (g)	Heading date (days)	Plant height (cm)	Panicle weight (g)	Panicle length (cm)
1	3,958	9.7	141.3	2.85	62.2	113.0	3.48	23.2
2	3,449	8.6	162.2	2.75	65.5	112.4	4.05	23.8
3	2,958	8.4	114.5	2.85	60.7	107.6	3.03	22.2
4	3,847	9.4	143.4	2.85	60.0	111.7	3.78	23.2
5	3,094	8.2	120.4	2.80	60.0	110.1	3.25	23.2
6	3,528	8.9	137.0	2.85	60.7	111.8	3.43	23.1
7	3,443	9.1	138.9	2.85	62.2	111.9	3.45	22.9
8	3,368	9.4	147.9	2.83	62.2	112.3	3.75	23.5
9	3,238	9.9	129.7	2.78	62.2	111.7	3.25	23.2
10	3,535	10.0	127.2	2.88	61.5	110.9	3.35	22.9
11	3,353	9.3	130.2	2.78	60.7	110.5	3.35	23.0
12	3,466	9.4	155.9	2.75	61.5	111.2	4.08	24.5
13	3,423	9.4	132.7	2.98	64.0	111.0	3.43	23.1
14	3,560	9.6	138.6	2.73	61.5	111.5	3.40	23.3

15	3,572	9.3	129.0	2.93	60.7	110.6	3.50	22.9
16	3,032	7.7	121.6	2.83	60.0	108.3	3.25	22.5
Mean	3,427	9.1	135.7	2.83	61.6	111.0	3.48	23.2
F value	2.72	2.56	3.09	0.63	3.89	1.17	2.06	2.12
LSD 5%	456	1.14	20.63	—	2.14	—	0.57	1.01
LSD 1%	610	—	27.55	—	2.86	—	—	—

Early application of MCPA and EPTC/2,4-D significantly delayed the date of heading whereas the plots heavily infested with weeds such as non-weeded check and Molinate headed earlier than others. No significant difference among treatments was found in plant height taken at maturity, but treatments with lower yield were generally associated with shorter plant height. Panicle weight and Panicle lenght were also significantly affected by the treatment, showing that weed competition was effective in reducing panicle weight and panicle length of rice.

SUMMARY

The effects of some herbicides and herbicides combinations on the control of weeds in paddy field evaluated at the Chiayi Agricultural Experiment Station, Chiayi, Taiwan, in the second crop of 1967 are summarized.

Broadleaves were the major weeds of the experimental plots at the early stage of growth. but grasses, particularly *Paspalum scrobiculatum* became the predominant weeds in some plots at the later stages. Sedges never became an important weed in the experimental fields,

NPE, KN_3, and Dichlobenil gave good control of weeds which were followed by EPTC/2,4-D, and Trifluralin. Pyridinol and Molinate controlled weeds poorly under the conditions of this experiment. MCPA+handweeding also resulted in a satisfactory control of weeds. In general, chemicals followed by MCPA gave more effective control of weeds than those applied alone.

Rice plant was injured by Pyridinol, NPE, EPTC/2,4-D, and late application of MCPA. As a result, the growth of rice plant was inhibited in the early stage, showing the reduction in tillers per hill and plant height. Weed competition with rice became apparent at heading stage, and plant height and tillers per hill in the plots with heavy weed infestation were greatly affected.

Weeded check, Pyridinol+MCPA, Dichlobenil +MCPA, Dichlobenil, KN_3+MCPA and Molinate+MCPA outyielded non-weeded check, differences being significant statistically. Weed competition with rice caused a loss of yield by 926 kg per ha or a reduction of 30.5 %. Single application of Pyridinol gave the lowest yield due to its toxicity to rice and poor control of weeds, whereas low yield of Molinate was caused primarily by heavy infestation of weeds.

LITERATURE CITED

1. Chang, W. L. 1965. Comparative study of weed control methods in rice. Jour. Taiwan Agr. Res. 14 (1) : 1-14.
2. Food and Agriculture Organization. 1967. Weeds in rice fields. The Report of the Three Technical Working Parties of the International Rice Commission. (1966) : 54-56.
3 Moomaw, J. C. , V. P. Novero, and A. C. Tauro 1966. Rice weed control in tropical monsoon climates: problems and prospects. Internat. Rice Comm. Newsletter 15(4): 1-16.
4. Moomaw, J. C. 1967. Weed control. Ann. Rep. Int'l Rice Res. Inst. (1966):168-170.
5. Shaw, W. C. and L. L. Danielson. 1961. The control of weeds in seed crops. The Year-book of Agriculture. pp 280-287.
6. Smith, R. J. Jr. and W. C. Shaw, 1966. *Weeds and Their Control in Rice Production.* USDA Handbook No.292. 64 pp.
7. Tang, W. T, and W. F. Tsai. 1967. Testing of some herbicides in paddy field. Sci Agr. 15(11, 12) :341-344.
8. Tang, W. T. and H. P. Wu. 1965a. Testing of some herbicides in paddy field. Jour. Agr. Assoc. China. New Series. 49 : 15-24.
9. Tang, W. T. and H. P. Wu. 1965b. Testing of some herbicides in paddy field. Memoirs Col. Agr. Nat. Taiwan Univ. 8(2):1-12.

稻田殺草劑之治草效果

張　萬　來

摘　要

本文係報告嘉義農業試驗分所與國際稻米研究所合作於民國56年第二期作舉辦之稻田殺草劑藥效觀察試驗之結果。

NPE, KN_3 與 Dichlobenil 殺草效果最佳，EPTC/2.4-D 與 Trifluralin 次之， Pyrldinol 與 Molinate 最劣， MCPA十人工除草之處理治草效果亦佳，試驗區之什草以濶葉草居多，故一般言之，各種殺草劑加用 MCPA 之處理，治草效果均較其單獨使用者爲佳。

Pyridinol, NPE, EPTC/2.4-D 與後期施用之 MCPA 對水稻均具藥害，水稻初期之株高，每株分蘗均受到抑制，其發育乃受影響，水稻受什草生長競爭之爲害情形，在其抽穗期前後始顯出。一般治草效果較差之處理，其株高，每株分蘗均受到影響。

人工除草， Pyridinol+MCPA, Dichlobenil+MCPA, Diohlobenil, KN_3+MCPA, 與 Molinate+MCPA 之稻谷產量均超過不除草區 ， 水稻因什草生長競爭而每公頃稻谷減產 926公斤， 達30.5%。 Pyridinol 單用處理因受藥害及什草競爭等雙重影響， 致每公頃稻谷產量最低 ， Molinate 單用處理之低產，顯受什草爲害所致。

REACTION OF RICE VARIETIES TO THE PHYTOTOXICITY OF A NEW HERBICIDE, ROUNDUP

W. L. Chang*

INTRODUCTION

In the recent screening experiments for new herbicides conducted by some experiment stations in Taiwan, Roundup was found to be highly toxic to rice. The occurrence of certain varieties of specific crops resistant to particular herbicides has been reported frequently. Price and Klingman (1958) reported that wheat and oat varieties responded differently to varying treatments of 2,4-D. Hodgson et al. (1964) also detected differential response of certain barley and wheat varieties to 7 herbicides. Information of this type could be of great value in screening programs of new herbicides. This experiment was conducted to determine the phytotoxicity of Roundup on a japonica and an indica varieties of rice.

MATERIALS AND METHODS

Two rice varieties, Chianung 242, a Japonica-type "ponlai" variety developed by the Chiayi Agricultural Experiment Station and IR 8, an indica variety released by the International Rice Research Institute (IRRI) were used in this experiment. The chemical, Roundup, used in this experiment is a product of the Monsanto Company, USA. The Roundup is a combination of Ramrod (CP 31393, 2 Chloro-N-isoprophylacetanilide) 7.5% and 2,4-D (2,4-dichlorophenoxyacetic acid) at 2.5% for a total active percentage of 10% in granular formulation. It was applied at two stages namely at 3 and 10 days after transplanting at the rate of 0.5, 1.0, 2.0 and 4.0 kgs. ai/ha (or 5, 10, 20, and 40 kgs product/ha), with a non-application included as a check treatment. Two rice varieties, 2 dates of application, and 5 dosage rates were combined in a $2\times2\times5$ factorial experiment in randomized complete blocks with 3 replications. The experiment was conducted in the screen house of the Chiayi Agricultural Experiment Station. Clay pots with total area of 314 cm^2 per pot were used for the planting of rice. Two-week old seedlings were transplanted on August 30, 1967 with 3 seedlings in each pot. Ammonium sulphate, calcium superphosphate, and potassium sulphate were used as carriers of N, P_2O_5, and K_2O which were applied at the rate of 100, 50, and 50 kgs per ha, respectively. Phytotoxicity readings were made at 4 weeks after transplanting by an arbitrary 0-4 scale devised by the author.

RESULTS AND DISCUSSION

Rice plant showed symptoms of toxicity about one week after the chemical was applied. Chlorosis on leaf blade was the first symptom of toxicity visible on rice plant. Later when rice plant was more severely affected, it showed a sign of stunting and leaf blades at the lower part started to wilt. A complete kill of rice plants in plots applied with higher dosages of chemical was detected at 2 to 3 weeks after the application of the

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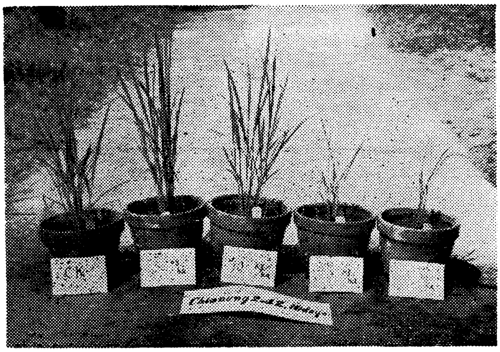
chemical. The results of phytotoxicity rating made at 4 weeks after transplanting is given in Table 1 as well as in Figure 1.

Table 1. Phytotoxicity rating of rice plant at 4 weeks after transplanting*

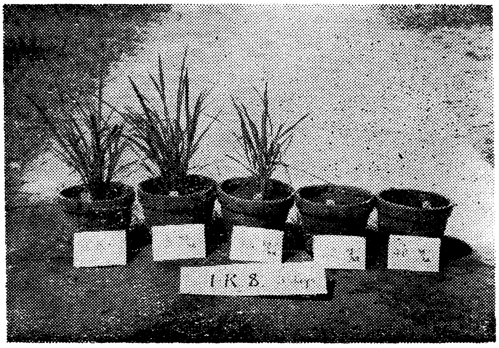
Variety	Date of application (days after transplanting)	Active rate (kg/ha)				
		CK	0.5	1.0	2.0	4.0
Chianung 242	3	0	0	0	1	4
	10	0	0.5	1	3.5	4
IR 8	3	0	0	0.5	2.5	3.5
	10	0	1	2.5	4	4

*0=no toxicity, 4=heaviest toxicity or complete kill of rice plant.

Chianung 242, 3 days.



Chianung 242, 10 days



IR 8, 3 days,

IR 8, 10 days.

Figure 1. Rice plants showing different degree of phytotoxicity symptoms at 4 weeks after transplanting.

Table 1. Shows that Roundup applied at the rate of 0.5 and 1.0 kg per ha of active ingredient did not cause any serious injury to rice plant. However, severe toxicity was evident when the rate exceeded 2.0 kg per ha of active material. The results of this experiment were slightly different from those obtained at IRRI (Moomaw, 1967) where only a light toxicity was recorded even the dosage rate was as high as 4.0 kg per ha. Since the recommended rate of this chemical is about 3.0 to 5.0 kgs of active material per ha for the effective control of weeds, Roundup as the present 10% granular specially made for evaluation in Taiwan appears unacceptable for paddy rice.

Roundup applied 3 days after transplanting appeared to cause less toxicity on rice plant in comparison with that of 10 days after transplanting, indicating that toxicity of this chemical on rice may be greatly reduced if early post-emergence or pre-emergence applications are made.

Chianung 242 was found to be more tolerant to the toxicity of Roundup than IR 8, although the difference is not so great. The result seems to suggest that japonica variety is more resistant to this particular chemical injury. Okamoto *et al.* (1960) also reported that japonica varieties of rice were generally more resistant to the toxicity of phenyl mercuric acetate whereas most indica ones are highly sensitive to the toxicity of this fungicide.

SUMMARY

The reaction of a japonica-type rice variety, Chianung 242, and an indica-type rice variety, IR 8, to the toxicity of a new herbicide, Roundup, was evaluated at the Chiayi Agricultural Experiment Station in September of 1967. Roundup exceeded the active rate of 2.0 kg per ha was highly toxic to rice plant. The phytotoxicity of rice plant was lighter when Roundup was applied at 3 days instead of 10 days after transplanting. Japonica rice variety, Chianung 242 appeared to be more tolerant to the toxicity of Rundup than indica variety, IR 8.

LITERATURE CITED

(1). Hodgson, J. M., F. P. Thrasher, and R. F. Eslick. 1964. Effects of eight herbicides on yields of barley and wheat varieties. Crop Sci. 4 (3) : 307-310.

(2). Moomaw, J. C. 1967. Personal communications.

(3). Okamoto, H., T. Hamamoto, E. Hamaya, and G. C. Marks. 1960. Studies on the phytotoxicity of various organomercuric compounds to Japanese and exotic varieties of rice plants and the efficiency of those compounds against rice blast in the field. Bull. Chugoku Agr. Exp. Sta. No. 6:225-282.

(4). Price, C. D. and G. C. Klingman. 1958. Wheat and oat varietal responses to applications of alkanolamine salt of 2,4-D. Agron. J. 50 (4):200-204.

水稻品種對新殺草劑 Roundup 藥害之反應

張 萬 來

摘　要

本試驗以測定不同型水稻品種對新殺草劑 Roundup 藥害之反應爲目的。供試材料爲日本型品種，嘉農242號，印度型品種，IR8 等兩品種。Roundup 由 Ramrod (CP 31393)7.5%與 2.4-D 2.5%混合製成爲有效成分10%之粒劑，是美國 Monsanto 公司爲在臺灣試驗而特別製成之產品。其施用量分爲對照，每公頃有效藥量0.5，1.0，2.0及4.0公斤，分別於挿秧後 3 日及10日撒施於盆栽水稻，並按各處理藥害之輕重分級計分。由此調査結果得知，Roundup 對供試水稻品種均具藥害，惟日本型品種，嘉農242號呈現藥害之程度似較印度型品種，IR8 者輕微。Roundup 施用量若超過每公頃有效成分2.0公斤以上時，就能引起供試水稻品種嚴重之藥害，惟挿秧後 3 日施用者似較挿秧後10日施用者爲輕。

抗銹病大豆新品種—臺農三號之育成

鄭 玉 威　詹 國 連

一、引　　言

大豆銹病（Phakopsora pachyrhizi, Syd.）爲近年來本省最嚴重之大豆病害，迄今在栽培品種中，尚無能抵抗者。銹病爲害大豆時，除豆葉提早枯萎變黃，豆株提前成熟外，最糟的是豆莢不會飽滿，豆粒扁平，以致產量減低甚鉅。根據本所『成熟前採種試驗（1963）』結果，十石大豆在早收一星期時，種子百粒重減輕8.8%，早收二星期則減輕 21.6%；又在本所的『銹病藥劑防治試驗（1964）』中亦指出，不同時期噴用『大生78』的增產效果（與不噴大生的對照相比），最低爲 361%，最高可達 1109%，平均爲 891%，由此可見銹病對於大豆產量損失的嚴重了。本所有鑑及此，乃自民國49年起，積極進行大豆抗銹病育種工作，而幸運的是在由美國引進的全世界性3000個大豆品種育種材料中，發現 PI 200492 及 PI 200490 二個中度抗銹病之品種，並隨即利用之與本所早期育成的早熟豐產但感染銹病的農試 H-11 品系舉行交配，先後經民國 50 年至55年之後代繁殖、分離、選拔、產量比較等一系列之試驗，終在農試 H-11 ×PI 200492 之組合中，選出具有抗銹病性並豐產之農試63—11品系，自民國54年秋季起，參加全省大豆區域試驗，並於55年秋在高雄區農業改良場協辦下，在高屏地區舉辦新品系示範試驗，56年春季復在臺南、嘉義、雲林三縣農會主持下，於該三地區共試種20公頃，深得該地區農民之好評，爲使該品系能正式推廣，增加農民收益起見，農試所已於去年秋季施行原原種種子之繁殖，並於56年12月26日申請農林廳雜糧作物新品種命名審查委員會審查，通過准予命名爲臺農三號。

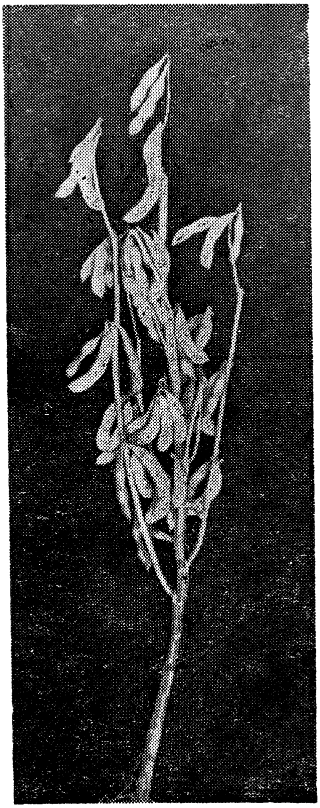


圖.大豆新品種—臺農三號

二、新品種「臺農三號」之育成

臺農三號大豆是於民國49年夏季雜交的，母本爲農試 H-11，父本是 PI 200492，於民國52年夏季固定，乃進行初級，中級及高級產量比較試驗（共計春作四次，夏作三次），茲列出高級產量比較試驗，區域試驗及地方示範三項成績如下。

表一、高級產量比較試驗（53—56年，試驗地點：苗栗農校農場）

1.春　作

年　份	品　種　名　稱	生育日數（天）	產量（公斤/公頃）	產量指數（%）
53	臺農三號	107	2871**	236.9
	臺大高雄五號(CK)	99	1211	100.0
54	臺農三號	110	1.219*	267.0
	臺大高雄五號(CK)	110	456	100.0
55	臺農三號	122	2433**	120.6
	臺大高雄五號(CK)	114	2016	100.0
56（註）	臺農三號	101	2072**	139.3
	臺大高雄五號(CK)	97	1488	100.0

（註）56年春作在苗栗地區大豆銹病僅輕微發生。

2.夏作

年　份	品　種　名　稱	生育日數（天）	產量（公斤/公頃）	產量指數（%）
53	臺農三號	89	2162**	123.5
	臺大高雄五號(CK).	88	1750	100.0
54	臺農三號	99	2788	100.4
	臺大高雄五號(CK)	99	2775	100.0
55	臺農三號	101	1443*	109.5
	臺大高雄五號(CK)	100	1317	100.0

*在5%平準顯著　　　　**在1%平準顯著

就苗栗四個年頭共七個季節之試驗成績觀之，無論在春季或夏季，在銹病發生或不發生之季節，新品種臺農三號之產量，均顯著地較目前之推廣品種臺大高雄五號爲優，而在銹病發生嚴重之季節，如54年春季，則新品種在產量上之增加，益爲明顯。

表二：全省大豆新品種區域試驗成績（民國54—55年，由各區農業改良場辦理）

1.秋作

年份	地　點	品　種　名　稱	生育日數（天）	株高(公分)	分　枝　數	產　量（公斤/公頃）	產量指數（%）
54	屏東市	臺農三號	86	35	3.0	1557	152.0
		臺大高雄五號(CK)	86	41	3.7	1025	100.0
55	屏東市	臺農三號	88	29	2.4	1775	117.2
		臺大高雄五號(CK)	84	32	2.6	1514	100.0

2.春作

年份	地 點	品 種 名 稱	生育日數（天）	株 高（公分）	分 枝 數	產 量（公斤/公頃）	產量指數（%）
55	屏東市	臺農三號	90	46	3.7	2549	140.0
		臺大高雄五號(CK)	80	41	4.4	1818	100.0
	臺中市	臺農三號	100	54	2.9	1880	278.0
		臺大高雄五號(CK)	97	59	3.3	470	100.0
	花蓮縣	臺農三號	110	30	3.9	1973	115.0
		臺大高雄五號(CK)	94	28	3.8	1710	100.0
	新竹縣	臺農三號	113	37	5.1	1847	214.5
		臺大高雄五號(CK)	106	37	4.5	861	100.0
	臺東縣	臺農三號	94	29	2.9	1773	118.4
		臺大高雄五號(CK)	94	28	3.2	1501	100.0

以區域試驗之成績觀之，秋作在屏東市的產量指數，民國54年秋爲52%，55年秋爲17.2%，此項年度間的差異，是因爲前者是銹病嚴重發生的年份，臺農三號的抗病性發生了作用，而後者(55年秋)係大豆銹病輕微發生的結果，是比較其產量能力的最佳時機。其次是在春作各地區的增產指數，最低是花蓮縣的15%，最高是臺中市的 178 %，平均增產指數爲53%，此顯然地表示在本省春季大豆銹病發生嚴重之下，本品種的優異性。

表三：新品種地方示範成績（55年秋作，由高雄區農業改良場主辦）

示 範 地 點	品 種 名 稱	產量公斤/公頃	產 量 指 數	產 量 位 次
東 港	臺農三號	2781.5	97.7	4
	臺大高雄五號(CK)	2865.5	100.0	2
崁 頂	臺農三號	2494.2	122.7	1
	臺大高雄五號(CK)	2032.9	100.0	4
內 埔	臺農三號	2429.0	103.6	2
	臺大高雄五號(CK)	2342.6	1.000	4
里 港	臺農三號	2823.2	100.8	2
	臺大高雄五號(CK)	2729.4	100.0	5
橋 頭	臺農三號	2354.4	114.6	3
	臺大高雄五號(CK)	2054.4	100.0	5

註：55年秋季高屏地區之大豆銹病僅輕微發生。

三、新品種「臺農三號」之特性

（一）對大豆銹病抵抗力強：新品種在高雄區農業改良場舉辦的大豆品種銹病檢定試驗結果，其抗病性居84個品種之首，同時其發病時期亦較一般感病品種為遲，是以對於產量上之損失極爲輕微，茲摘出其部份檢定結果如表四：

表四：新品種臺農三號銹病罹病率（%）

品種名稱	54年秋作	55年春作		
	屏東市	屏東市	九如鄉	內埔鄉
臺農三號	29.66	50.74	22.11	1.47
臺大高雄五號	73.70	96.56	70.76	63.63

（二）產量高：按照區域試驗結果，新品種較對照種臺大高雄五號秋作增產17—52%，春作增產15—178%，而新品種產量之增高，在銹病發生嚴重之季節更爲顯著。

（三）對光線及溫度較爲鈍感：在全省特別是高屏地區，春秋二季皆可種植，生育日數秋作爲90天，春作爲90—100天。

（四）株高適中，抗倒伏：新品種株高約50—65公分，在任何季節決不倒伏。

六、新品種之優劣點及栽培要點

臺農三號大豆品種具早熟性，宜於春秋二作，秋作以禾根豆栽培時可密植，種粒大，百粒種子重18—20公克，種皮稍有龜裂爲其缺點。

本品種之育成承農復會之資助，苗栗農工職校之惠予合作，以及該校實習農場諸位先生之協助，於茲一併致謝。

參　考　文　獻

1. 蔡財旺、謝寬興，1967，大豆抗銹病品種檢定及藥劑防治試驗。臺灣省高雄區農業改良場編印。
2. 詹國連、鄭玉威，1965，大豆銹病藥劑防治試驗，雜糧作物試驗研究簡報（五十三年度），臺灣省農林廳編印。
3. 劉文慶，1963，臺灣雜糧作物品種圖說（第三章大豆），農林廳及農復會合編。
4. 鄭玉威，1963，大豆成熟前採種對於種子之影響；雜糧作物試驗研究簡報（五十三年度），臺灣省農林廳編印。
5. C. R. Weber, 1967, Registration of Hark, Disoy, Magna, and Prize soybeans, Crop Science, Vol. 7, No. 4, pp 403-404.

THE BREEDING OF RUST RESISTANCE SOYBEAN "TAINUNG 3"

Y. W. Cheng[1] and K. L. Chan[2]

SUMMARY

"Tainung 3" soybean (Glycine max (L.) merr.) was selected from F7 plants of the cross Nung-shih H-11 X PI 200492 in 1963. Prior to release Tainung 3 was indentified by the number Nung-shih 63-11. It is adapted to the whole Island in the spring and winter crops.

Tainung 3 is characterized by purple flowers, brown pubescence, large seed size (18-20 grams per 100 seeds), yellow seed coats and brown hila. Tainung 3 outyielded Tai-ta-Kaohsiung 5 (Check variety, 1800-2500 Kg/ha in both spring and winter crops), 17-52% in the winter crop and 15-178% in the spring crop. The more severe the rust disease, the bigger difference was found in the yleld. It has similar maturity with Tai-ta-Kaohsiung 5. Tainung 3 is resistant to lodging and to soybean rust (phakopsora pachyrhizi, Syd.) that caused leaves wilting at early infections, and defoliations at later stages. The only one undesirable character is the cracking of seed coat.

Tainung 3 was named in December 1967, and will be released in 1968. Taiwan Agricu ltural Research Institute is responsible for maintenance of breeder seeds.

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臺灣紅黃色灰化土生成之研究

I. 石牌粘土之礦物性質研究[1]

梁 鉅 榮[2]　　黎 靜 韻[3]

一、前　　言

紅黃色灰化土 (Red-yellow podzolic soils) 爲本省北部邱陵山地最普遍之氣候性土壤，亦爲北部之茶、柑橘與一般混合林木之主要產地，石牌粘土最初發現於宜蘭縣之石牌，其剖面形態爲化育相當良好之黃色灰化土 (yellow podzolic soils) 可作爲本省北部黃色灰化土之代表。從形態上，尤其是土壤顏色，與紅棕壤顯然有別；過去數年來筆者研究本省紅棕壤之生成，從理化性及礦物性作綜合研討 (21)；發覺過去本省通稱之紅棕壤，在新分類系統上實即紅黃色灰化土，本研究志在研究該型土壤之礦物成分，尤其是粘土礦物成分，以爲該類土壤之生成，並研討其與紅棕壤之差別，進而爲實用價值上作基本參考。

二、紅黃色灰化土生成之理論

I. 紅色或黃色灰化土獨立土類之成立

1. 紅色灰化土：根據美國農部1938年之年報記載 (1) 紅色灰化土在美國之東南部與印度之西部頗多，表面具1～2吋之枯枝葉，有 matlike 之化育，其下爲灰色或暗棕灰腐植化礦質土 A_1 層，約2～3吋厚，再下爲一黃灰或淡玫瑰灰色，多少具砂質的 A_2 層，厚約數吋，與一紅或棕紅色團粒構造之粘土 B 層，1～3呎厚，並具網狀斑紋磚紅化的母質。
2. 黃色灰化土：(1) 黃色灰化土化育於較紅色灰化土爲濕潤之土壤環境，或由於不完全的排水，或由於空氣濕度過高，當地雨量豐富，其 A_2 層較紅色灰化土爲灰色與深厚，而其 B 層爲以褪黃色代替紅色，其磚紅化之母質顏色常具高量之黃色。
3. 紅黃色灰化土：1949年 Thorp 與 Smith 氏 (2) 合併上列兩種土類爲紅黃色灰化土 (Red-yellow podzolic soils) 其定義如下：一類化育良好之酸性土壤，具薄有機質 A_1 層，蓋上淡色漂白A_2層，其下爲紅黃或黃色，而具較多之粘質層，母質多有矽質的粗網狀條紋，或紅、黃、棕與淡灰斑紋，爲該土壤深層之特質。

II 各學者對紅黃色灰化土礦物特性之研究

1. Simmonson 之見解 (3) 氏於1950年將紅色與黃色灰化土之生成，曾作一檢討，假定該類土壤生成之顯著作用，係粘土礦物在其轉變的母質之深層生成，與其在土體之漸變消失，作爲係破壞速度超越生成速度所致。
2. Nyun & McCalb 1955年之說明 (4)：指出美國北加羅蘭州 (North Carolina) 之紅棕壤經已和緩的灰土化，並顯示某些紅黃色灰化土之特質，就礦物立論，此種剖面顯示鐵、鎂與長石礦物幾已完全消失，其轉變之物質爲顯著之高嶺石 (kaolinite)，多水高嶺土 (Halloysite) 與 Fe_2O_3 礦物，原始的與次生的積聚其最高濃度於 B 層。
3. Stanley & McCalb 1959 年之進一步研究 (5)：氏對紅黃色灰化土有關礦物性質之特徵如下：(A)長石轉變爲高嶺石或多水高嶺土，惟無中間程度者發見。(B) 黑雲母及白雲母顯然

1.本研究之完成，得國家長期發展科學委員會之補助，加州大學Dr.I. Barshad與臺灣大學洪崑煌教授之協助，謹此致謝。

2. 3. 臺灣省農業試驗所技正及技士

經由蛭石（Vermiculite）之中間物以轉變為高嶺石（C）在紅棕壤與紅色灰化土中蛭石與水鋁氧（Gibbsite）占次要成分，且C_{12}層無水鋁氧，惟高嶺石與蛭石則存在於各部，甚至細砂然，(D)中間性剖面之高嶺石是自40～60%，蛭石自30～40%，多水高嶺土被限於B_2層與在其下，並不超20%（A_2層除外），在B_{31}層下，無水鋁氧發見，(E)黃色灰化土之高嶺石範圍自40～80%與20～40%之蛭石，C層之水鋁氧超高嶺石以上：（F）由水成岩生成之剖面，則與上述者有異，除紅色灰化土之B_{31}層外，在B層下並無水鋁氧發見，各剖面中高嶺石最豐，或等於蛭石，伊來石（Illite）係存在於中間性與黃色灰化土，惟無存於紅色灰化土中，(G)由頁岩生成之剖面，C與D層有微晶高嶺石（montmorillonite）少量存在。

4. 美國農部第七次土壤分類草案（9），1960年在第七次國際土壤學會發表之草案中，紅黃色灰化土被列為 *Ultisols* 綱，*Ochrults*亞綱之 *Typochrults* 土類，係濕潤區由涼溫以至熱帶之土壤，母質並非高度鹽基性，原生植物為森林，本類土壤在其坋粒與砂粒部分，僅具少數可風化的礦物，並少量之2：1構造粘土，粘粒部分具低鹽基交換能量，少於40m.e./100，由其具備大量可風化礦物或2：1構造粘土。

5. Bennema 氏之見解（6）：氏於1963年發表對熱帶、亞熱帶高地之紅色與黃色土壤，曾作一通盤之研究，認為磚紅土化的灰化土（Lateritic Podzolic Soils）係熱帶與亞熱帶高地之最重要之紅色或黃色土壤，指包括土壤之具有一粘土底層，質地較A層為粘重，構造呈化育完善之塊狀或稜狀，而具Clay skin者，或亦可包括土壤之具矽質B層，惟在AB層間有一顯著之質地差異者，本類土壤根據其B層之鹽基飽和度，復分為二亞類：(A) B層具低鹽基飽和度者；(B) B層具中高鹽基飽和度者，茲將以上二亞類之土壤述之如下：前者具有一化育完全之輕質地A_2層與一粘質塊狀B層，表土常呈紅色或黃色，底土則較紅，B層之鹽基飽和度低，A層則中等，粘土礦物則包括三氧化鐵，與大部1：1格子之矽質粘土礦物，三氧化鋁常不出現；粘土礦物之鹽基交換能量高，常較其同質地之紅壤（Latosols）具有較多量之可交換性鋁，B層每具有自然粘土（Natural clay），指出該土較紅壤少具安定之粒團作用（Aggregation），滲透性亦較紅壤為低，排水狀況常中等，後者係由較少矽質性母質化育而成，正常狀態下，本類土壤缺A_2層，B層具中至高鹽基飽和度之磚紅土化灰化土。

6. Harris 氏之說明（7）：氏對紅黃色灰化土，認為係具顯明之質地 *B* 層，該層具超15%之粘粒，粘粒部分之成分有相當之變異，除石英外，具數種原始礦物者屬之；復根據其B_2層塊狀構造之有無以為次一區分，有塊狀構造者，稱為紅黃色磚紅土化灰化土（Red-yellow latosolic podzolic soils）云。

Ⅲ 臺灣之紅黃色灰化土

周昌芸氏（11）稱“發育良好之灰化紅黃壤（即紅黃色灰化土），有顯著之A.B.C.層，多見於落葉林或混合林之起伏邱陵山地，海拔約500至1,500公尺，尤以臺北基隆及宜蘭間，經年濕潤多雨之山區，分佈最廣，在地勢比較平坦之山坡，偶可見及發育完善之灰化紅黃壤剖面，最上部往往有一極薄之A_0層，其下緊接灰色A_1層，灰黃色A_2層，再下則為鮮黃或紅黃色粘重之B層，全部呈強酸性反應，母質以砂頁岩為主，但多數剖面無A_2層，有時整個A層，被侵蝕截去，而黃色之B層完全露出，故嘗有人稱之為黃壤，其成土作用，係介於紅壤化與灰壤化之間，本類土壤多為森林區域，間有闢作農田者，除有機質含量較高於紅壤，其他肥力相似”。

根據十餘年來土壤調查報告（12,13,14,15,16,17,18,19,20），筆者對本土類曾有一簡略之綜合說明（10）謂本類土壤係化育於邱陵岡嶺1500公尺以下。北部三百公尺以上，南部500公尺以上之山地地帶，其地面植物覆蓋繁茂，而地形亦較平整處，土壤剖面化育較為完善，惟由於山嶺傾斜，多峻峭，起伏靡定，一般沖蝕劇烈，故常見之土壤剖面頗多殘缺不完，每與石質土混合存在，

發見之土系計有①興化寮系，②樂野系，③鳳凰山系，④大鞍系，⑤谷關系，⑥扇平系，⑦五指山系，⑧高態系，⑨石牌系，⑩雙連系等共10個，估計面積約225,100公頃，占全省總面積約6.3%。筆者研究本省紅棕壤之生成，綜合結論謂大多數土系，應歸屬紅黃色灰化土(21)，若然則本土類更爲廣泛，分佈亦更廣。

三、石牌粘土之礦物性研究

I 土壤剖面之自然形態：

石牌粘土發見於臺北至宜蘭公路，接近宜蘭三角冲積地之坎口，當地之地名爲石牌，因以名之，本型土壤之剖面形態如下：

A_{00} 層 8 — 0 公分：粗有機質枯枝落葉積聚層。

A_{11} 層 0 — 5 公分：乾時橄欖棕色 2.5y4/4 (D)，潤時極深灰棕色 2.5y3/2 (m)，有機質與礦物質混合層，粒狀、鬆疏，PH4.5，富含有機質12.7%。

A_{12} 層 5 — 9 公分：乾時棕色 10yR5/3(D)，潤時暗棕色 10yR3/3 (m)，粘土，團粒構造，鬆軟，PH4.5，仍富含有機質7.8%。

A_2 層 9 —17公分：乾時淡棕色 10yR6/3(D)，潤時暗棕色 10yR4/3 (m)，粘土，段狀構造，柔軟，PH4.3，有機質爲4.5%。

B_{21} 層17—60公分：乾時淺黃色 10yR6/4(D)，潤時黃棕色 10yR5/6 (m)，粘土，無構造，段狀，粘結狀態， PH4.8，有機質1.8%。

B_{22} 層60—130公分：顏色較上層略淺，粘土， PH5.0，有機質 1 %，餘同上層。

130 公分以下：泥質砂岩。

當地地形：山嶺性，拔海800公尺左右。

植　　物：茅草，附近栽植柳杉。

排　　水：良好。

氣　　候：濕潤溫帶，年雨量 3,000 公厘以上。

Ⅱ 粘粒部分之分離：

1.石牌粘土之代表剖面機械成分之分析。

表1.石牌粘土代表剖面機械成分之分析

Table 1. Mechanical composition of Shih-pai clay (105°C)

Sampling No.	厚度(公分) Depth cm.	2-1 m.m.	1-0.5 m.m.	0.5-0.25 m.m.	0.25-0.11 m.m.	0.11-0.05 m.m.	2-0.05 m.m.	0.05-0.002 m.m.	<0.002 m.m.	質地 Texture
584	0— 5	1.10	0.61	1.24	3.77	16.78	23.50	31.32	45.18	粘土 clay
585	5— 9	0.41	0.36	3.55	1.40	13.86	19.58	33.24	47.18	〃
586	9—17	0.45	0.20	3.50	1.60	13.83	19.58	36.24	43.18	〃
587	17—60	0.20	0.35	1.20	3.60	12.15	17.50	31.32	51.18	〃
588	60-130	0.50	0.68	1.74	2.42	12.22	17.58	31.24	51.18	〃

2.粘粒部分之分離

應用 1 N Na_2EDTA 爲分散劑，將各層供試土壤放於瓶中，放置於搖土機上，振盪四小時，分散其粒子，取出後使其通過300號篩，去除其粗粒部分，將土液加入 30% H_2O_2 ，除去其有機質，在蒸氣水鍋上作用數次蒸乾，加水使再分散，續於搖土機上振盪一小時，取出，調整其

PH 至 9，傾於 100ml之量筒內，應用土粒沉降理論，計算時間以分離 $<2\mu$ 以下之粘粒，重覆四、五次，收集其粘粒懸浮液，貯於大玻璃瓶內，以備各項分析之用。

3.粘粒部分（$<2\mu$）之粘土礦物成分之分析：

a. X 光分析：Barshad氏修正鹽漿法(8)。

b. 示差熱分析（Differential Thermal Analysis）:Barshad：法(8)，及臺大洪氏法(22)。

c. 熱重量分析（Thermal Gravimetric Analysis）:Barshad 法(8)。

d. 游離鐵之分析：Barshad法(8)。

e. 陽離子交換能量試驗：Barshad 法(8)。

4.全土壤之數化學性分析：

a. PH：玻璃電極法。

b. 有機質 Walklay-Black 法。

c. 陽離子交換能量 Barshad法(8)。

5.試驗結果及討論：

a. 分析結果及其說明：

（1）X—光分析：

X—光分析，曾就每樣本進行，室溫 .400°C及570°C三種不同溫度處理下之分析，由照片結果，綜合其特徵如表 2。

表2. 石牌粘土X—光照片分析結果

Table 2. Interplaner Spacing and Estimated Intensities in X-ray Powder Diagram of Glyceral-wet $<2\mu$ Clay of Shih-pai Clay

Spacing Å / Name of Minerals	處理 Treatment	14.20	12.00	10.09	7.16	5.01	4.86	4.48	3.50	3.35
		蛭石 Vermiculite	Inter. lazer	白雲母 Muscovite	高嶺石 Kaolinite	2nd line of Musc.	水鋁氧 gibbsite	Common in all	2nd line of kao.	3rd line of Musc.
Sampling No.		Intensities								
584	room temp.°C	m	v.m.	m	s	w	w	v.s	s	s
584	400°C	—	—	s	m	w	w	v.s	s	s
584	570°C	—	—	s	—	v.w	v.w	v.s	—	m
585	room temp°C	m	v.w	m	s	w	w	v.s	s	s
585	400°C	—	—	s	s	w	w	v.s	s	s
585	570°C	—	—	s	—	v.w	v.w	s	—	m
586	room temp°C	w	v.w	w	s	m	m	v.s	v.s	s
586	400°C	—	—	m	s	w	w	v.s	s	s
587	room temp°C	m	v.w	w	m	m	m	v.s	s	s
587	570°C	—	—	s	—	w	w	v.s	—	m
588	room temp°C	m	v.w	w	m	m	m	v.s	s	s
588	570°C	—	—	s	—	w	w	v.s	—	m

vs. 極强，s强，m. 中等，w弱，v.w. 極弱

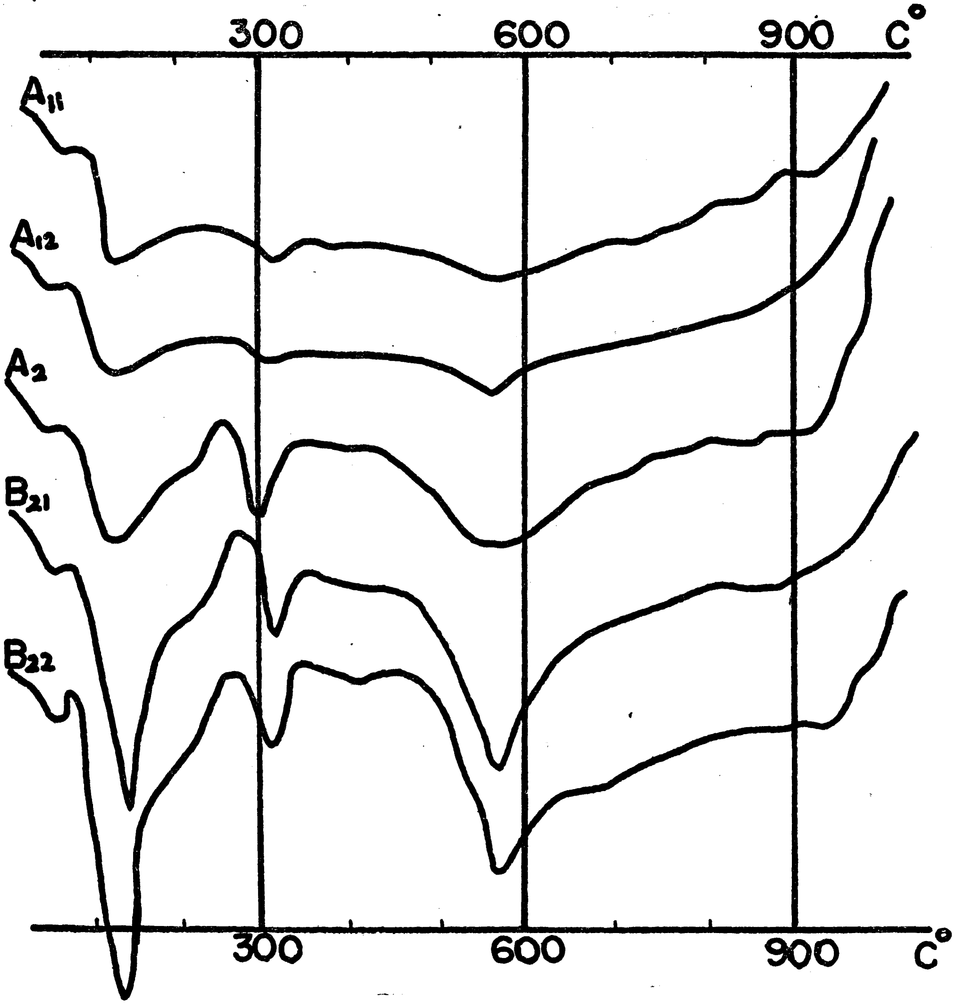
上表結果從 X 一光照片觀察及量度結晶內格距離 Å 之結果，至易鑑別三種礦物之存在，蛭石顯示於 14.20Å，白雲母顯示於 10.09Å，5.01Å 及 3.35Å 三線，高嶺石顯示於 7.16Å及 3.58Å d(001)之結晶內格距離，而水鋁氧之 4.86Å 雖與 5.01Å 易於混雜頗難分出，惟與以後之示差熱 D.T.A.試驗對證，亦足證明其存在。

（2）示差熱 D.T.A 分析結果如圖一、二、三。

圖一：示差熱曲線係利用臺大之簡易儀器記錄所得。

圖二及圖三：係與美國柏克萊加州大學土壤系 Barshad 博士合作，郵寄土壤樣本，利用該粘土礦物研究室自動 D.T.A. 記錄計照相所得之結果，三圖比較可說明如下：

A. 石牌粘土剖面五層次之曲線形態與兩種粘土礦物標準曲線對照，在 300°C左右



圖一：石牌粘土之示差熱曲線（臺大儀器測得）

FIG. 1. D.T.A. CURVES OF SHIH-PAI CLAY (ANALYSED IN UNI, OF TAIWAN)

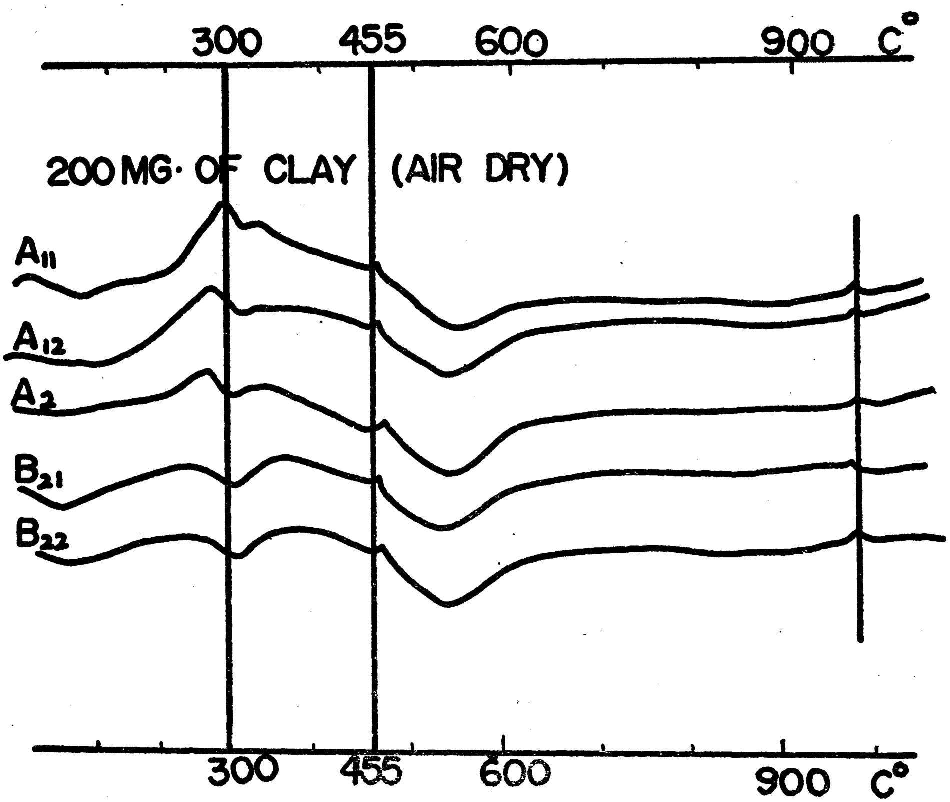
，有顯明之內熱破面出現，或吸熱谷出現，尤以三、四、五層形態較顯，面積較寬，表示剖面五層有數不同量之水鋁氧存在，愈向下層而愈顯。

B. 次則於455°C再有內熱破面開始，而於 600°C 左右終止，V 字形態對稱相當明顯，尤以三、四、五層爲然，證明高嶺石之存在。

C. 圖一與圖二曲線之趨勢相同，僅在低溫時之曲線未盡符合，此與主要粘土礦物無關，而兩不同地點，不同儀器試驗之結果，尚稱符合，益證明該兩種礦物之存在顯然。

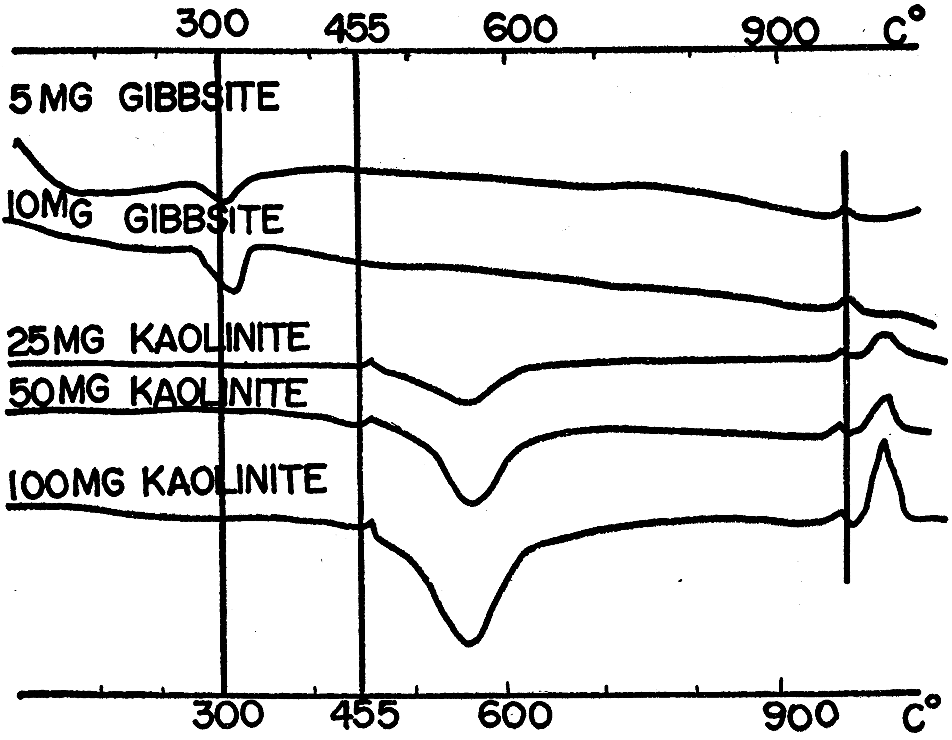
D. 由圖二圖三比對標準曲線之V形面積，可獲高嶺石與水鋁氧量如表5。

（3）熱重量分析結果如表3。



圖二：石牌粘土之示差熱曲線（加大儀器測得）

FIG. 2. D.T.A. CURVES OF SHIH-PAI CLAY (ANALYSIS IN DEPART. OF SOIL. U. C. BERKELEY.)



圖三：二種標準礦物之示差熱曲線

FIG. 3. D.T.A. CURVES OF TWO STANDARD CLAY MINERALS.

表3. 熱重量分析結果表%。

Table 3. Result of Thermal Gravimetric Analysis

土 號 Soil No.	厚 度 Depth cm.	吸 收 水 分 Absorbed water		Loss between 150-325°C	Loss between 325-1000°C	結 晶 水 分 Total crystal water
		150°C basis	ignited basis	燃 灼 土 計 Ignited basis		
584	0- 1	7.25	8.17	4.20	8.41	12.61
585	5- 9	7.56	8.82	4.68	7.49	12.17
586	9- 17	7.19	8.06	5.09	7.06	12.15
587	17- 60	6.81	7.59	4.79	6.22	11.01
588	60-130	6.51	7.25	3.96	7.36	11.32

由表知石牌粘土各層之粘粒，在低溫損失水分7.25—8.82%，在高溫損失水分均在11—12.6%，指示該粘土具1：1與2：1礦物之存在。

（4）化學分析

進行之化學分析不多，僅就數關係最切之項目進行，結果如表4。

表4. 石牌粘土數化學性質分析結果

Table 4. Some Chemical Analysis of Shih-pai Clay

土 號 Sampling No.	層 次 Horizon	厚 度 Depth cm.	全土壤 whole soils			粘土部分 clay fraction $<2\mu$	
			PH	有機質 organic matter %	陽離子交換能量 C.E.C. m.e./100	游離鐵 Free irom Fe_2O_3%	陽離子交換能量 C.E.C. m.e./100
584	1	0-5	4.5	12.7	48	12	32
585	2	5-9	4.5	7.8	40	15	38
586	3	9-17	4.3	4.7	34	16	30
587	4	17-60	4.8	1.8	30	18	36
588	5	60-130	5.0	1.0	27	17	32

一般以言，本型土壤之 PH，均屬强酸性，底層酸度略遜，有機質含量表層頗豐，17公分以下底層均低，陽離子交換能量亦愈下而愈低，粘土部分之游離鐵，則愈向下層而愈高。

(5) 粘土礦物量之推算

粘土礦物量，除高嶺石與水鋁氧由 D.T.A. 鑑別外，餘由 X-ray 照片線圈强弱度之鑑別，經驗之分析者可推算其成分之大概，本次分析經加州大學 Barshed 博士之鑑別與推算，該其他粘土礦物之成分可列如表 5 。

表5. 石牌粘土之粘土礦物成分表

Table 5. The Clay Mineral Composition of Shih-pai Clay

土 號 Soil No.	厚 度 Depth cm.	高嶺石 Kaolinite	白雲母 Muscovite	蛭石 Vermiculite	水鋁氧 Gibbsite	游離鐵 Free Fe_2O_3	石英 Quartz	其他 Others
584	0-5	25	35	17	1	12	6	4
585	5-9	28	30	16	1	15	5	5
586	9-17	29	30	13	2	16	5	5
587	17-60	21	30	18	3	18	5	5
588	60-130	21	30	19	3	17	5	5

由表知石牌粘土之粘土礦物成分，以白雲母爲主，高嶺石與蛭石次之，三氧化鐵亦占相當成分，而以石英及水鋁氧最少。

b. 討論

從剖面形態觀察，本剖面之層次區分，經試列其次序，如剖面說明，即第一層爲 A_{11}層，第二層爲 A_{12} 層，第三層爲 A_2 層，第四層爲 B_{21} 層，第五層爲 B_{22} 層，從顏色上鑑別，其灰土化頗顯。

就物理分析之機械成分（如表 1），各層粘粒之成分均在40%上以，惟第三層43%，第四、五層各爲51%，兩者之差異在 8 %，依美國農部第七次草案之新分類，謂

其爲質地 B 層，亦頗合理。

就粘土礦物之種類及其成分研討，本剖面與本省北部過去通稱之紅棕壤之分析結果（21），至爲接近，即以白雲母、高嶺石與蛭石爲其三主要成分，並含少量之水鋁氧，就風化作用言，該土壤之礦物風化程序爲白雲母經由蛭石以生成高嶺石，以至於水鋁氧，係理所當然，惟高嶺石含量並不豐富，而且白雲母與蛭石亦存留大部，顯然風化尙淺。

就數化學成分之分析結果（表４），證之於粘土部分者，游離鐵之含量，一般較本省北部昔稱之紅棕壤者爲高（21），且由剖面形態試列之 A_2 層之游離鐵亦似過高，再自其他化學成分觀之，如全土壤之有機質含量，第三層即 A_1 層，雖較第一、二層爲低，然尙存留有4.5%之多，謂爲 A_2 層，不無疑慮？故本剖面之灰土化作用，從游離鐵、有機質及粘土礦物成分數項結果，僅能謂爲灰化作用尙在初期。

石牌粘土之土壤生成作用，僅憑粘土礦物成分與上列數項之形態，物理與化學之性質之研究，雖已明其大概，惟僅一剖面之分析，與二、三項之物理化學性質之判斷似嫌其不足，該土型在臺北、宜蘭一帶分佈頗廣，確有待進一步之理化性質之研究，與多採數代表剖面共同對證之必要。

6.結　論

a. 石牌粘土從其剖面形態與機械成分， A_2 層頗顯，質地 B 層亦然， 初步鑑定，謂爲黃色灰化土。

b. 從粘粒部分之粘土礦物成分討論，以其含高嶺石不高（<30%），且白雲母與蛭石尙存留大部（50%±），顯示風化尙淺。

c. 就全土壤化學成分中之有機質與粘粒部分之游離鐵含量，則由形態與物理鑑別之 A_2 層該兩項成分仍高，灰土化作用之淋洗或漂白作用應尙在初期。

d. 本研究進行粘土礦物成分與三、四項理化性質對該黃色灰化土生成之闡釋，有感資料未全，有待進一步多採土樣與研究其他理化性質之必要。

摘　　要

1. 石牌粘土爲本省北部山地最普遍之氣候性土壤，——黃色灰化土，本研究之目的，在研究該型土壤之粘土礦物成分，以爲該土壤之生成及實用上應用之參考。

2. 試驗之項目包括 X 光分析，示差熱分析，熱重量分析及數種化學性之分析，如 PH 有機質，游離鐵及陽離子可交換能量等。

3. 試驗結果，詳列如表１、２、３、４、５及圖１、２、３等。

4. 根據石牌粘土剖面形態，與機械成分，則 A_2 層頗顯，質地 B 層亦然，初步鑑定謂爲黃色灰化土。

5. 從粘粒部分之粘土礦物成分討論，以其含高嶺石成分不高，且白雲母與蛭石尙存留大部，顯示本剖面之風化尙淺。

6. 由形態與機械成分鑑別之 A_2 層就其全土壤之化學成分中之有機質與粘粒部分之游離鐵含量言，則該兩項成分仍高，顯示灰土化作用之淋洗或漂白作用係尙在初期。

7. 本報告僅限於粘土礦物成分與三、四項理化性質，對黃色灰化土之生成研究，因未能作充分之闡釋，有待進一步多採土樣與研究其他理化性質之必要。

參考文獻

Literature cited

1. U.S.D.A.(1938) Year book of Agriculture, Soils and Men. P. 398—409
2. Throp, J. & Smith, G. D. (1949) Higher categories of soil classification. Soil Sci. Vol. 67: No. 2 P. 111-120
3. Simonson, R. W. (1950) Genesis and classification of red-yellow podzolic soils. Soil Sci. Soc. Amer. Proc. 14 P. 316-319
4. Nyun, M. A. & McCaleb, S. R. (1955) The reddish brown lateritic soil of the North Caroline Piedment region. Soil Sci. 80:27-41
5. Stanley, B & McCaleb, S. R. (1959) The genesis of the red-yellow podzolic soils. Soil Sci. Soc. Amer. Proc. Vol. 23:P. 164-168
6. Bennema, J. (1963) The red and yellow soils of the tropical and subtropical uplands. Soil Sci. Vol. 95: P. 250-257
7. Harris, S. A. (1963) On the classification of Latosols and tropical and brown earths of high rainfall area. Soil Sci. Vol. 96 P. 210-215
8. Barshad, I. (1960) Soil mineralogy, Mineography Uni. of Califoria. Berkeley Press.
9. U.S.D.A. (1960) Soil classification: A comprehension system. 7th Approximation Soil Survey Staff, Soil Conservation Service.
10. Leung, K. W. & Chen, T. T. (1957) Soil of Taiwan. Jour. of the Agri. Assoc. of China. New Series 20: 1-26
11. 周昌蕓：(1953) 臺灣之土壤　臺灣經濟年報25—27頁
12. 席連之 (1951) 臺灣省土壤調查報告書　臺肥公司叢刊第五種
13. 茹皆耀等 (1947) 臺中縣之土壤　臺灣農試所專報第六號
14. 梁鉅榮等 (1951) 臺南縣之土壤　臺灣農試所報告第六號
15. 梁鉅榮等 (1953) 高雄縣之土壤　臺灣農試所報告第十一號
16. 梁鉅榮等 (1954) 屏東縣之土壤　臺灣農試所報告第十四號
17. 陳春泉、梁鉅榮 (1962) 桃園縣之土壤　臺灣農試所報告第二十一號
18. 曾浴沂等 (1963) 新竹縣之土壤　臺灣農試所報告第二十二號
19. 朱惠民、梁鉅榮 (1964) 苗栗縣之土壤　臺灣農試所報告第二十三號
20 梁鉅榮等：臺北、宜蘭縣之土壤 (未印稿)
21. 梁鉅榮、黎靜韻 (1965) 臺灣省紅棕壤生成之綜合研究　中華農學會新52期

SOIL DEVELOPMENT STUDY OF RED-YELLOW PODZOLIC SOILS IN TAIWAN

—a. Study on the clay mineral of Shih-pai clay—

by

K. W. Leung and C. Y. Lai

Summary

1. The Shih-pai clay is the most common soil of hilly land in the northern part of Taiwan. The purpose of this study is to want to know the clay mineral composition of this soil type for the reference of the genesis and practical use of it.
2. Items of this experiment consist of X-ray analysis, thermal differential analysis, thermogravimetric analysis and some chemical analyses which include pH, organic matter, free iron oxide and cation exchange capacity.
3. The results are showing on the tables 1,2,3,4,5, and the figures 1,2,3, etc.
4. It was identified from the beginning that Shih-pai clay could be said as yellow podzolic soils base on the apparent A_2 horizon from the profile morphology and the argillic horizon according to the mechanical analysis. (table 1.)
5. From the view of the clay mineral composition (table 5.) of $<2\mu$ clay fraction. The weathering of these soils are apparently young, because of that the knolinite content is not high and large part of muscovite and vermiculite are still remained in the solum.
6. The A_2 horizon that had identified base on the morphology and mechanical analysis was not clear due to its high content of organic matter and free iron oxide. (table 4.) So that the podzolization or the bleaching reaction of this soil was still in the young stage.
7. Data of this study are not enough for the interpretation of the genesis of yellow podzolic soils due to only analyse clay mineral and few chemical and physical properties of the soils. So it is needed to collect some more soil samples and to analyes other physical and chemical properties for the advance study.

硫酸之應用對EDTA法測定植物體鈣鎂之影響

(對高鈣量樣本之處理法)

李 蘭 帝

前 言

在植物體樣本的分解濕式法的應用甚廣，其優點已爲大家所知。通常使用的酸包括三種即硫酸，過氯酸及硝酸等。硫酸的存在在鈣的測定場合常被人憂慮。其原因爲硫酸與鈣生成硫酸鈣而不易溶解的緣故。因此在測定鈣的時候硫酸被認爲不可使用。在另一面硫酸的存在在分解時却有不少用處，如使分解進行順利，防止爆炸，不須多照顧等優點。因此在大量樣本的處理上硫酸的使用甚有價值。爲了上述的原因筆者認爲對於硫酸的影響有進步檢討的必要。結果發現以本文所述的測定法硫酸的存在在鈣量少於 4 %時並不發生影響。不但如此，尙可利用硫酸鈣在酒精溶液的難溶性而除去鈣。此法在測定鎂時對高鈣量的樣本很有價值。

實驗方法 (1)

取 1M $CaCl_2$ 溶液 0.5，1.0，1.5 及 2.0ml 相當於鈣量 20.40，60 及 80 mg 等，各裝於分解瓶。加濃硫酸加 1 c.c.加熱至沸騰。冷却後加水至 80c.c.，加熱15分使硫酸鈣溶解（避免沸騰）。待冷後稀釋至 100ml。鈣量20及 40 mg 之二支硫酸鈣完全溶解，60及 80 mg二支尙可看到硫酸鈣之沉澱。待沉澱澄清之後取 1ml 上澄液稀釋至 15c.c. 加 4N KOH 1.5c.c. 加 Calcein (0.1%)一滴，以 0.001M GEDTA 滴定至螢光消失。螢光的觀察在日光燈下，後面豎一塊黑板由側面對黑板觀察。

表1　硫酸對不同鈣量測定之影響

Table 1. Effect of H_2SO_4 on the determination of Ca.

鈣量 Amount of Ca taken (mg)	20	40	60	80
所測鈣量 Amount of Ca observed (mg)	20	40	58	66

實驗方法 (2)

取兩種植物樣本，一個爲水稻葉，另一個爲柑桔葉。此兩種樣本性質相距很大。水稻鈣量少，矽酸多，柑桔葉恰相反。用兩種不同分解法，主要爲一個有硫酸另一個不加硫酸。

秤取樣本 1g 於 100c.c. 分解瓶 。 加濃硝酸 4c.c. 先以低溫分解後加硫酸及過氯酸各 1c.c.。在無硫酸分解法則只加過氯酸 3c.c. 然後加熱至分解完全（須加熱至有過氯酸的白煙）。分解後加水 80c.c. 加溫使硫酸鈣溶解（避免沸騰），稀釋至 100ml 待沉澱澄清。

水稻取分解液 2ml，柑桔葉則取 1ml ，稀解至 15c.c. 加 Triethanolamine (1:2) 三滴， 4N KOH 1.5c.c. Calcein (0.1%) 一滴，加過剩的 0.001 M GEDTA 溶液之後以 0.001M 鈣標準液逆滴定。終點判斷與實驗方法(1)同。

表2 硫酸對植物體鈣測定之影響

Table 2. Effect of H_2SO_4 on the determination of Ca in plant tissue

分解法 Acids used	水稻葉(%)	柑桔葉(%)
H_2SO_4-$HClO_4$-HNO_3	0,430	3,86
$HClO_4$-HNO_3	0,436	3,85

實驗方法 (3)

取柑桔葉的分解液 20ml 於 50ml 的定容瓶。加95%酒精各15、20、25及 30c.c. 等。加水至標線混合後放置一夜。取上澄液 5ml（酒精15及 20c.c. 的兩支尚有混濁），加水至 15c.c. 仍依實驗方法(2)之要領滴定鈣量。

再取上澄液 5ml 加水至 15c.c. 加 Triethanolamine (1:2)三滴，10% Hydroxylamine 三滴，NH_4OH (1:1) 2c.c. 及少量 BT 指示劑。加過剩的 0.001M EDTA 標準液後以 0.001M 鈣標準液逆滴定。由藍色變為紫色可判斷一滴之差。終點附近須特別小心，因變色與終點相差有點時間。

表3 不同酒精量對柑桔葉鎂測定之影響

Table 3. Effect of ethyl alcohol on the determination of Mg in citrus leaf.

酒精量(c.c.) c.c. alc in 50ml	ml of 0.001 M EDTA (Ca+Mg)	ml of 0.001 M GEDTA (Ca)	差 Difference
15	9.15	6.65	2.50
20	5.50	3.00	2.50
25	3.75	1.20	2.55
30	3.10	0.60	2.50

討 論

由表1的結果知道鈣量達到 60mg 時硫酸鈣的溶解已開始成問題。此量可視為溶解量的上線。實際應用時以 50mg 為上線似乎較安全。此量雖不多但因本法使用微量法，測定鈣量通常在 0.4mg 以下，50mg 即相當於樣本的5%，可說寬度相當大。如有超出此量的情形，可用更多量的水去溶解，對測定仍無影響。

表2的結果顯示在實際樣品測定時硫酸的存在無影響。其理由可由實驗方法(1)的結果說明。再可知大量矽酸的存在（如水稻葉）亦無影響。

實驗方法(3)的目的是為了求一個較理想的除鈣方法而做的。EDTA 法的缺點之一乃不能直接測定鎂。鎂常以 (Ca+Mg)－Ca 的方法求。此法如鈣量高時對鎂的測定甚不利。此情形在 Ca/Mg 比超出10以上時更為嚴重。除鈣之方法有多種。鎢酸鈉及草酸常被人使用。兩法均使鎂的滴定終點不明瞭，並有鎂共沉之虞。筆者試酒精溶液除硫酸鈣的方法，覺得較為理想。此法 Harold 等(1)已有報告。據他們的報告酒精要在75至80%時硫酸鈣的沉澱才能完全。鎂的滴定前又須把酒精蒸發掉。本實驗酒精濃度均未達到75%，故鈣的除去並不完全，所以仍須測定鈣以資矯正。但因酒精濃度低無須把酒精蒸發乾，而直接可供滴定。終點靈敏度不受影響。由表3可知酒精用量在20至 30c.c.（約相當於40至60%酒精濃度）時較為理想。此法的優點為(1)分解時所加的硫酸可利用，(2)沉澱在酸性溶液故無

鎂共沉之虞。

本實驗如不除鈣，鈣的滴定數將近 20ml，顯然無法準確測出鎂量。

（註）本實驗所用 Chelate 劑及指示劑的命名法依 Dotite 試藥（日本同仁藥化學研究所）的命名法。

參 考 文 獻

(1) Harold L. Barrows and Elmer C. Simpson. 1962. An EDTA Method for the Direct Routine Determination of Calcium and Magnesium in Soils and Plant Tissue. Soil Sci. Soc. Amm. Proc. Vol 26, No. 5, P 443～445.

The use of sulfuric acid for the determination of calcium and magnesium in plant sample by EDTA method

by

L. T. Li

Summary

Sulfuric acid used in the wet digestion of plant sample puts some limit to the determination of calcium. According to the method described here, as high as 4% of the calcium in plant sample can be safely determined.

The sulfuric acid can also be used for partial seperation of calcium in alcoholic solution, which makes the magnesium determination more accurate when the sample contains high amount of calcium. Alcohol solution of 50% concentration was found satisfactory for this purpose without removal of alcohol before titration.

擴散法在硝酸態氮定量上的應用

(低濃度試液的處理法)

李　蘭　帝

前　言

Conway 氏的擴散法在大量樣本的銨態氮定量上確有很多的幫助，如果用簡單的方法能把硝酸態氮還原成銨，則擴散法必為硝酸態氮定量的良法。 Conway 氏(1)曾使用 Devada 合金以達此目的。亦有用硫酸鈦的方法(2)(3)，前者有產生氫氣之缺點，後者適當的試藥難以獲得。筆者曾用鋅粉及硫酸第一鐵為還原劑，而得良好的結果，故提供大家參考。

此法應用於低濃度之試液甚理想，較其他比色法為簡便，對較濃之試液亦可應用自如。

試藥配製及其他

(1)鋅粉

(2)硫酸第一鐵， $FeSO_4$ $5H_2O$.

(3)硼酸液：2%溶液，加 Bromocresol green 為指示劑(約 0.08%)。以稀 HCl 和 NaOH 調整 pH 使其呈綠色。pH 值在4.5左右。

(4)0.002N H_2SO_4: 由標定好的 0.1N 標準液稀釋，再以標準銨液依擴散法標定後使用。

(5)擴散皿‥市面有專用品。但亦可培養皿 (Petri dish) 代替。內經約 9公分。同大小者方可，以膠帶封閉。

(6)小杯：形如蒸發皿，內經約5分。

實　驗　方　法

取供試液10至 30 c.c. (氮量在 200μg 以下) 於擴散皿。加鋅粉及硫酸第一鐵各 0.2g。攪拌使硫酸第一鐵溶解並使鋅粉分散。內放小杯 (內裝 3c.c. 的硼酸液)。加 4N NaOH 3c.c. 後施蓋，並以膠帶封閉。輕輕搖動使溶液充分混合。此為測定銨態及硝酸態氮總和之用。另取同量供試液，仍依上法 (但不加鋅及硫酸第一鐵) 測定銨態氮。在 35°C 保溫 3 天之後取出硼酸液，以 0.002 N H_2SO_4 滴定至原有綠色為止。由總和滴定數減去銨態氮滴定數即為硝酸態氮之滴定數。應做空白試驗以矯正試藥中之氮量。 0.002 N H_2SO_4 1 ml 相當於 28μg 的氮。

結果與討論

本試驗使用純 KNO_3 及 $(NH_4)_2SO_4$ ，各配 10ppm 氮溶液。硝酸態氮即依本法測定。標準酸液則使用標準硫酸銨液，依擴散法標定。供試液均取硝酸態 100μg, 另加所需水量以做成不同液量，其結果在表 1。

表 1. 不同液量對硝酸態氮測定值之影響

Table 1. Nitrate-N as determined in differemt solution volume from 100μg of N

供試液量 (c.c.) Volume of sample solution (c.c.)	所測氮量 (μg) Amount of N found (μg)		
10	96.0		96.0
30	94.6 96.0	96.0	96.0 96.0
50	92.6	95.0	94.0

由表 1 得知此測定法之回收率爲96%。如液量增加至 50c.c. 稍有降下的趨勢。

本法並未考慮亞硝酸之存在。如有亞硝酸則包含在硝酸態之內。如欲知亞硝酸之量須做前處理。請參考 Bremner (2)(3)之報告。

硝酸的還原多用 Devada 合金。此合金產生氫氣，在密封室裡成爲引起誤差的原因 (5) 。鋅因其過電壓（Overvoltage）高，在室溫不產生氫氣。惟僅用鋅，硝酸的還原不完全，故必有硫酸第一鐵存在。鐵的功用恐怕在乎其催化作用。 Bremner (4)謂，用硫酸鈦亦須鐵之存在。

本法如應用於較濃的試料（氮量在 0.2 至 1 mg 者），硼酸液及標準酸液須予以調整。請參照筆者報告(6）。惟鋅及硫酸第一鐵之用量無須調整。

參 考 文 獻

(1) Conway, E. J. 1947. Microdiffusion Analysis and Volumetric Error, Ed. 2. Crosby Lockwood London

(2) Bremner, J. M. and Shåw, K. 1955 Determination of ammonia and nitrate in soil. J. Agr . Sci. 46:320-328

(3) Bremner J. M. and Shaw, K. 1958 Denitrification in soil. I. method of investigation. J. Agr Sci. 51: 22-39

(4) Ho C. L., and Bremner, J. M. 1960. Unpublished work. Department of Agronomy. Iowa State University.

(1)至(4)均在 "Method of Soil Analysis" Part 2. (The American Society of Agronomy 出版）一書上找到要點。

(5) 永井恭三：1965，硝酸態室息の微量擴散分析における濾紙の使用について，日土肥，36卷，12號。

(6) 李蘭帝：1966, 大量植物樣本氮磷鉀的迅速測定法。農業研究15 (2) ：1～5。

Determination of Nitrate by Microdiffusion

by

L. T. Li

Summery

Zinc powder and ferrous sulphate are used as reducing agents for the determination of nitrate by microdiffusion. The ammonia is absorbed in boric acid and titrated with 0.002N acid. No hydrogen is evolved as in using Devada alloy. The method is simple and suitable for the solution of low concentration (1 to 6 ppm of nitrogen using 30 ml of sample solutin). The recovery is about 96%.

小菜蛾之形性觀察及其天敵考查

吳 國 家

小菜蛾爲世界性之十字花科蔬菜害蟲。而其爲害十字花科蔬菜，往昔不如今日之嚴重，此或由於普遍、經常使用殺蟲劑防治後，小菜蛾似有獲得獨持之優良環境，而應用現代殺蟲劑防治，反得相反之效果。本報告爲敍述小菜蛾各期蟲態之生活習性及天敵種類等等。此項區區資料或可藉以部份解釋小菜蛾所以特別猖獗之原因，供蔬菜害蟲防治上之參考。（本文承陶技正家駒、梁技正同庭指導與鼓勵，文成後並蒙陶技正賜正與吳技佐幹成代爲繪製小菜蛾幼蟲小繭蜂及黃海燕小姐繪製小菜蛾生活史圖，特誌於此，藉表謝忱。）

一、小菜蛾之各期蟲態

卵：小菜蛾之卵扁卵形，魚鱗狀。分佈於葉上，色白乃至檸檬黃色。表面有小而圓形之隆起部。孵化前由卵殼外面可透見其幼蟲之外形。卵長約0.44公厘，濶約0.26公厘。

幼蟲：小菜蛾之幼蟲長筒形，體毛較少，具有僞足5對。計齡期4齡，每次脫皮後，其頭濶與其體濶相等。但待幼蟲取食而進行生長後，體則變爲紡綞形。第一齡幼蟲全體無色，頭暗褐色，頭顱淺色，但具暗褐色光澤。前胸背之中背線兩側有不規則之褐色斑紋。腹部中央部分最濶，而兩端漸形細小。腹部具剛毛，剛毛之基部環有淺褐色澤。而在足上亦有此種色澤之痕跡。以後各齡期幼蟲形與第一齡幼蟲相同，惟在放大鏡下觀察之，可辨有少許之不同。前胸背板斑紋變爲許多褐色之斑點，成爲剛毛之基部。環繞腹部剛毛四周之色澤區更爲明顯，且較第一齡期更大而更深。最後一齡因其在胃內積集食物，故體常呈綠色。四齡幼蟲之頭顱闊及其體之長度爲第一齡0.16×1.7公厘，第二齡0.25×3.5公厘，第三齡0.37×7.0公厘，第四齡 0.61×11.2 公厘。最後一齡至前蛹期則無脫皮現象，僅外形稍有不同，即前蛹之頭及胸部更爲收縮，並呈淡綠色。

蛹：小菜蛾之蛹前端圓形，胸部最濶，而向後端漸形細小。口器明顯。翅芽長達第五腹節末端。初化蛹時色灰綠，而逐漸變成淺棕色。蛹體有褐色斑紋，體長約7公厘。蛹體包被於兩端開口之精細網狀絲繭內。

成蟲：小菜蛾之成蟲爲細小灰褐色之蛾。展翅約17.7公厘。休止時前翅置於體之兩側，接合於背上。後翅暗灰色。側面觀之，蟲體後端稍爲上舉，一條乳黃色背紋由前至後，被其餘不規則黑色條紋區分爲三部分不甚明顯之波狀紋區域，宛如鑽石之閃光，故小菜蛾名爲 Diamond back moth。小菜蛾個體間雖有更明顯之色澤變化，但通常雌蟲色澤較雄蟲淺而斑紋亦欠明顯。

二、生活習性

生活習性觀察方法

（1）成蟲之飼養：自田間採集蛹體，置於玻璃瓶內，瓶口蒙蓋紗布，待其羽化後，將成對的雌雄蛾，放入口徑4公分，高10公分之玻璃瓶中，瓶內放入青梗白菜葉片供成蟲產卵之用。葉柄下端裹以溼潤棉花，以防止葉片急速乾燥。同時將各玻璃瓶分別編號，每日上下午各觀察一次，記錄其活動、交尾、產卵、壽命等情況。

（2）卵之飼（培）養：取成蟲產卵之葉片，分別記錄其卵數，產卵日期，時刻等。並逐日觀察卵粒之變化，注意其孵化之日期，時刻及孵化之歷時等項。

（3）幼蟲之飼養：用細毛筆筆尖將孵化之幼蟲小心的移至青梗白菜葉片上，每一葉片放飼一頭，然

後將葉片置於瓶中。所用之玻瓶與飼養成蟲者同。每日又將幼蟲用毛筆以同樣方法，移至新鮮葉片上，繼續飼養，並詳細觀察幼蟲之活動情形，取食習性及有無脫皮現象等事項。直至幼蟲老熟結繭化蛹，記錄蛹之歷期為止。

小菜蛾之生活習性

（1）成蟲之習性：成蟲一般均在上午7—9時羽化，但亦有延至下午3—4時者。羽化後休息於飼養瓶內之菜葉上，飼養瓶上或紗布蓋上，若不受外界驚動，常靜止不動。成蟲在上午羽化後，則於下午、傍晚或晚間即行交尾，翌日黃昏或夜間開始產卵。日間及夜間均有交尾情事。交尾時間20分～2小時不等。成蟲一生交尾數次，交尾時靜止，交尾空間不需很大。羽化後，雌雄在口徑1.5公分，長9公分之玻璃管內，即能交尾、產卵。卵產於玻璃管上亦能孵化。成蟲產卵期通常是3～5天，惟短者僅1天，長者多達8天，平均3.6天。產卵數以第一天及第二天為最多，佔總產卵數之80%，每一雌蟲產卵數頗不一致，據調查36頭雌成蟲產卵結果，最多者為245枚，最少者為18枚，平均121枚。成蟲趨光性很強，喜愛亮光。在室內飼養飛出時，則多飛往光亮之處。成蟲活動時間以傍晚至翌日清晨為多，尤以晚間6～11時最為活躍。成蟲雌雄比率據由幼蟲飼養至蛹羽化為成蟲，三次考查485頭結果，雌雄之比率為250：235，雌佔51.9%，略比雄蟲多些。成蟲壽命一般冬天較長，夏天較短。卵多產於葉片之主脈及支脈之處，葉背較葉面多些。有時亦產於葉柄上。在室內飼養時，亦有產於玻璃管上。卵為散產，有時3～4粒相聚一處。

卵：剛產下之卵色白，稍帶黃色，後漸變黃色，而孵化前1～5時，即變為褐色，最後變為黑色。卵期2～7天、3～4天為最多，平均3.9天，在定溫室內（23°c）為4天。孵化率據四次考查306粒結果，孵化之卵279粒，佔91.2%。

（2）幼蟲之習性：幼蟲孵化時間自20分至3小時不等，平均2小時，孵化時刻多在白天，自上午七時至下午五時均有孵化現象。初孵化之幼蟲在原處停留約15～40分鐘後，乃開始爬動，尋找食物，並行吐絲。卵產於葉面上，孵化之幼蟲多數遷移至葉背適當處，侵入葉內，潛食葉肉，留下表皮，形成白色透明之食痕，此為小菜蛾初齡幼蟲為害之唯一特徵。初齡幼蟲食量微小，但如蟲數多時，被害葉片亦易察見。第二齡幼蟲有時亦潛食葉肉，但待三、四齡幼蟲則在葉片上下穿孔，取食為害。幼蟲密集時，食完葉肉而留下葉脈，嚴重時亦食害葉柄。在花椰菜上能食害花蕾。幼蟲受驚時，有吐絲、假死、下垂習性。幼蟲性頗活潑，一旦受驚擾則迅速後退。如寄主不足取食時，常吐絲藉風力遷移或爬行遷移尋找食物。幼蟲一生脫皮三次，共計四齡。脫皮多在晝間進行。脫皮前靜止，並吐絲固定蟲體，進行脫皮。脫皮後靜止30分鐘至2小時不等，然後開始爬動，進行取食。食量隨齡期而增大，據調查40頭幼蟲之食量，為第一天食1.14平方公厘，第二天食3.16平方公厘，第三天食8.06平方公厘，第四天食22.50平方公厘，第五天食63.00平方公厘，第六天食134.55平方公厘，第七天食37.68平方公厘，第八天食0.33平方公厘。幼蟲一生共食葉面積為275.40平方公厘。老熟幼蟲在化蛹前3～5小時，即不進食，乃尋找適當處所化蛹。在飼養瓶內時，爬至蓋口紗布上、瓶壁上、葉片近葉脈或葉脈稍凹下處化蛹。化蛹前吐絲纏繞，作成紡錘形薄繭，幼蟲旋即化蛹其中，所脫之皮就近留於蛹體之末端。初化之蛹體呈綠色，後漸變淡綠色、黃綠色，最後變為黃色。蛹體如受外界干擾，仍能活動。蛹為自由蛹，自絲網外面可透見之。蛹期3～12日，平均6.3日。

生活年史：小菜蛾一年之中發生情形及出現代數，經54年（1965）6月開始飼養觀察，至55年（1966）7月為止，又分室內及室外（網室內）同時進行。據觀察結果，一年間室內發生19代（圖二），室外發生18代（圖三）。其每一代期間之長短，受氣溫之影響很大。室內完成一代為13～34天，平均16.8～20.6天，室外為13～37天，平均17.2～21.6天，在定溫室內（23°C）則為17～20天，平均18天。

小菜蛾田間發生密度，隨季節而異，據54年（1965）2月至5月調查甘藍20株之卵、幼蟲、蛹在植株上葉背及葉面分佈情形，如圖四所示。即在同一株上之卵、幼蟲及蛹之棲息密度，因月日而異。不論卵、幼蟲或蛹，均以葉背居多，因之，如行藥劑防治，葉之兩面必須完全噴到方可。

三、天　　敵

小菜蛾之天敵，以膜翅目寄生性姬蜂、小繭蜂、小蜂、卵蜂、雙翅目之寄生蠅爲主。據已知記錄已達23屬63種之多，並已行國際間交換及大量繁殖放飼，成爲生物防治別開生面之一環，而最成功之著例爲新西蘭。

臺灣小菜蛾之寄生性天敵，在臺北本所應用動物系園地內，發現兩種，即蛹寄生蜂，爲蛹姬蜂 *Diadromus* sp.＊，可能爲 *D. collaruis* Gravenhort，但有重複寄生蜂發生，該蜂亦屬姬蜂，爲 *Itoplectis naranyae* Ashmead.＊。

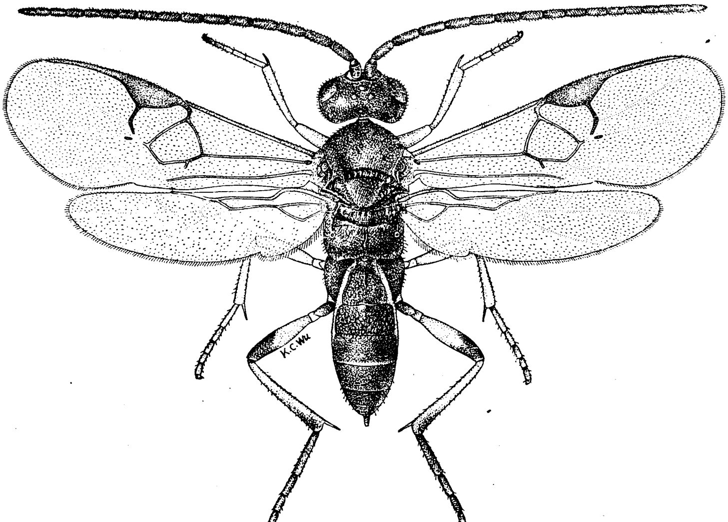
小菜蛾蛹寄生蜂在未施任何殺蟲劑之甘藍上，55年（1966）3月中旬採集162頭蛹，經室內飼育考查結果，寄生者63頭，達40%。

次爲小菜蛾幼蟲小繭蜂 *Apanteles plutellae* Kurdjumov.＊＊ 該蜂分佈於歐洲之烏克蘭、意大利、法國、荷蘭、非洲之摩落哥、利比亞、亞洲之印度、日本及臺灣，而臺灣爲新記錄。

小菜蛾幼蟲小繭蜂（圖一），成蟲雌雄體色均黑色。前中足之轉節、轉基節、腿節、脛節及跗節均黑色。前中足之基節、後足轉基節腿節、脛節、脛節距、肩板、腹節基部皆紅褐色。翅痣暗色。

頭之顏面全部及額區密佈點刻。顏面之凹陷部較接近上唇基片。後單眼與複眼分明。雌蟲觸角鞭節較頭、胸、腹之和爲長，但較頭、胸、腹之和長之2倍爲短。雄蟲觸角約爲頭、胸、腹和之3倍等長或短些，或爲胸部之3倍之長。

胸部沿中胸背板縱溝下行成一狹縱線及一大區域，該區至少佔據中胸背板之後半部。前緣及側緣有皺摺點刻，其他區域有光澤及點刻。後緣光滑、小楯板刻溝新月形，小楯板盤有皺摺點刻，或爲深



圖一　小菜蛾幼蟲小繭蜂 *Apanteles plutellae* Kurdjumov 雌

＊ 姬蜂學名承日本 Hyogo 農業大學 Setsuya Momoi 博士鑑定。

＊＊ 小繭蜂學名承英國皇家昆蟲研究所 R. G. Fennah 博士鑑定。

點刻。中縱區稍爲凹下，偶有一明顯之中縱隆起。翅之徑脈之第一橫線與橫肘脈等長，基脈上部短，後緣紋與翅痣等長。後足基節有皺紋，後足脛節距等長，約爲其後足跗節之基節之$\frac{1}{2}$長。

腹部第一腹背板基部爲深凹陷，中央十分膨大，有時有短中縱隆起，先端向上捲起，在膨大之基部略平滑，其他地方有皺摺點刻。第二腹背板有皺紋，第三腹背板平滑。以後各腹背板有細點刻。腹部腹板無中縱線。產卵管鞘較基節尤短，約爲第二、三腹節之和之長。產卵管較基節長，但較後足跗節之基節及第二節之和之長爲短。

小菜蛾幼蟲小繭蜂寄生率據55年（1966）2、3月間在本所未曾使用任何殺蟲劑之甘藍上採集三、四齡幼蟲，携回室內飼養，先後五次計164頭，其結果寄生者43頭，寄生率達 37.5 %。此蜂喜產卵於小菜蛾第二、三齡幼蟲，據考查10頭寄生蜂結果，小菜蛾幼蟲被其產卵後，經 7～10天，小繭蜂幼蟲老熟，鑽出寄主體外，結一白色小繭，化蛹其內。蛹經 6～8 天羽化，完成一代需13～18天，成蟲壽命 7～22天，被寄生之小菜蛾幼蟲自小繭蜂幼蟲老熟鑽出結繭後，始告死亡。一寄主幼蟲僅有一頭小繭蜂幼蟲寄生，故爲單獨寄生。而小菜蛾黃色小繭蜂 *Apanteles* sp. 因發現不多，暫略述之。

小菜蛾近年來為害嚴重性之探討

臺灣之小菜蛾由於冬季溫暖如春，照常發育爲害，故一年之中出現代數頗多，計室外18代，室內19代。因發生代數多，故對於外界不利於其生活上之物理、化學因子，可在短時間內產生抗性因子，形成抗性小種，代代相傳，以致無法用一種或同類衍化物之殺蟲劑來防治。最初如 D.D.T. B.H.C.後來又如 Malathion, Parathion Diazinon 等，先後均相繼失效。

又據考查不使用任何殺蟲劑之甘藍上，小菜蛾幼蟲及蛹被小繭蜂及姬蜂兩種寄生蜂寄生達77.5%（37.5%及40%）換言之，在未普遍應用殺蟲劑防治蔬菜害蟲以前，小菜蛾之密度平時已被此兩種寄生蜂控制高達 7 成或 7 成以上，無怪小菜蛾當時不爲主要之害蟲。固然，此項膚淺之觀察，不足以斷言小菜蛾在目前爲害嚴重之理由，但亦可解釋一二，作爲今後改進十字花科蔬菜害蟲防治技術上之參考。

應用殺蟲劑防治蔬菜害蟲，保持蔬菜固有之產量和品質，是無可諱言的，決不可以爲小菜蛾之因爲對任何一種殺蟲劑，因一年中繁殖代數多，容易產生抗性小種，和犧牲有效天敵寄生蜂等等而不使用殺蟲劑，以致影響其他害蟲之爲害，仍不能達到栽培蔬菜之目的。故應在防治小菜蛾其他方法上去尋求，如應用微生物來防治小菜蛾，以彌補其缺點。此種防治方法國外已有報告，再據本所陶技正家駒56年（1967）在越南西貢田間試驗結果，亦獲同樣效果，似可改變防治小菜蛾方策，以濟燃眉之急。

結　　論

臺灣十字花科蔬菜害蟲——小菜蛾，由於冬季溫暖，一年繁殖代數頗多，故對於殺蟲劑受自然淘汰法則，極易產生抗性小種，經常使用一種或類同之衍化物，失却防治效果。不但如此，平時控制七成以上之小菜蛾有效天敵之幼蟲小繭蜂及蛹姬蜂，在目前應用之各種殺蟲劑防治蔬菜害蟲情形下，無法立足，以平衡小菜蛾密度。因之，在此雙重作用下造成今日防治十字花科蔬菜害蟲上之難題。爲今後防治小菜蛾計，似可由藥劑防治以外之其他方法中去尋求。

參 考 文 獻

以下所列爲小菜蛾生活習性，天敵有關之文獻，至藥劑防治則槪未錄入。因迄目前尙無一種殺蟲劑可以持續而有效地防治小菜蛾幼蟲。

Ankersmit (G. W.) 1953 DDT-Resistance in *Plutella maculipennis* (Curtis) (Lep.) in Java, Bull. ent. Res. 44, 421-425.

Atwal (A.S.) 1955 Influence of temperature, photoperiod and food on the speed of development, longivity, fecundity and other qualities of the diamond-back moth *Plutella maculipennis* (Curtis) (Lepidoptera: Tineidae) Aust. J. Zool. 3, 185-221.

Beck (S. D,) 1965 Resistance of plants to insects, Annual Review of Entomology 10, 207

Blanchard (E. E.) 1947 Descriptions and notes on Argentine Microgasterines, Arthropoda 1, 6-22.

Bonder (G.) 1928 *Plutella maculipennis*, a serious pest of cabbage in Bahia, Chacaras e. Quintaes 28, 602.

Brethes (J.) 1923 The cabbage moth, *Plutella maculipennis*, Curt. An. Soc. Rural Argentina, 57, 162-166.

Cherian (M. G.) & Basheer (M.) 1939 *Brachymeria excarinata*, Gahan (Fam. Chalcididae) a pupal parasite of *Plutella maculipennis*, Curtis in South India, Proc. Indian Acad. Sci. 7 (B) 6. 289-299.

Delucchi (V.), Tadic (M.) & Bogavac (M.) 1954 L'elevage en masse de *Apanteles plutellae* Kurdji. (Hym., Braconidae) et de *Angitia tibialis* Grav. (Hym., Ichneumonidae), parasites endophages de *Plutella maculipennis*, Curt., et notes biologiques sur ces parasites, Plant Prot, 21, 20-41

De Silva (M. D.) 1961 Microbial control, 1. Laboratory tests on the susceptibility of the Lepidopterous pests of cabbage in Ceylon to commercially prepared *Bacillus thurigiensis* Berliner, Trop. Agriculturist 116, 273-286.

Dosse (G.) 1959 A hitherto unknown type of damage by *Plutella maculipennis* Curt. on winter rape and mustard, with supplements on the morphology of the larvae, Z. Pflkrankh. 66, 150-156.

Edwards (W.H.) 1930 A destructive pest of cruciferous crops, The small green cabbage worm, *Plutella maculipennis* Curt., J. Jamaica Agric. Soc. 34, 582-583.

Fischer (E.) 1929 Is a new outbreak of the cabbage moth, *Plutella maculipennis*, to be expected in 1929?, Die kranke Pflanze 6 66-68.

French (R. A.) & White (J. H.) 1960 The diamond-back moth outbreak of 1958, Plant Path. 9, 77-84.

Frost (S. W.) 1949 The diamond back moth in Pennsylvania, J. econ. Ent. 42, 681-682.

Fox (C. J. S.) & Jaques (R. P.) 1961 Field tests with *Bacillus thurigensis* Berliner and DDT for control of two pests of cabbage, Canad. J. Pl. Sci. 41 428-430.

Girault (A. A.) 1922 New Chalcid-flies from Eastern Australia, 3, Hymenoptera, Insector Inseitiae Menstrus, 10, 148-154.

Given (B. B.) 1944 Notes on the physical ecology of *Diadromus* (*Thraiilla*) *collaria* Grav. N. Z. J. Sci. Tech. 26 (A.), 198-201.

______________ The relative food-consumption of diamond back moth and white butterfly larvae, N. Z. J Sci. Tech. 26(A)195-197.

______________ Longevity of diamond back moth (*Plutella maculipennis*-) adults in relation to nutrition, N. Z. J. Sci. Tech. 26, 192-194.

Gray (R. A. M.) 1915 The prevention of egg-laying on turnips by the diamond back moth, J. Bd. Agric. London, 22. 222-226.

———————— 1931 The diamond back moth *Plutella maculipennis* during the years 1914-1929, J. r. Hort. Soc., 56, 48-55.

Gupta (P. D.) & Thorsteinson (A. J.) 1960 Food plant relationships of the diamond back moth (*Plutella maculipennis*, Curt.) 1. Gustation and olfaction in relation to bontanical specificity of larva, Ent. exp. appl 3, 241-250.

———————— 2. Sensory regulation of oviposition of the adult female, Ibid. 305-314.

Gunn (D.) 1917 The small cabbage moth (*Plutella maculipennis*, Curt.), Union S. African Dept. Agric., Pretoria Bull 8, 10 pp.

Gurney (W. E.) 1924 To control cabbage moth, Agric. Gaz. N. S. W. 35, 325.

Harcourt (D. C.) 1958 Biology of the diamond back moth, *Plutella maculipennis* (Curt.) (Lepidoptera: Plutellidae), in eastern Ontario, 1. Distribution, economic history, synonyms and general descriptions, 37th Rep. Quebec Soc. Prot. P1. 1955 155-160.

———————— 2. Life-history, behaviour and host relationships, Canad. Ent. 89, 554-564.

———————— Distribution of the immature stages of the diamond back moth, *Plutella maculipennis* (Curtis) (Lepidoptera: Plutellidae), Canad, Ent. 92, 517-521.

———————— 1961 Design of a sampling plan for studies on the population dynamics of the diamond back moth, *Plutella maculipennis* (Curtis) (Lepidoptera: Plutellidae), Cand. Ent. 93, 820-831.

Hardy (J. E.) 1938 *Plutella maculipennis*, Curt., its natural and biological control in England, Bull. ent. Res. 29, 343-372.

Harper Cray (R. A.) 1915 The prevention of diamond back moth outbreaks, Jl. North of England Hortic. Soc., nos. 53, 54, 197-201.

Hassanein (M. H.) 1958 Biological studies on the diamond back moth, *Plutella maculipennis* Curtis (Lepidoptera: Plutellidae), Bull. Soc. ent. Egypte 42 325-337.

Helson (C. A. H.) 1960 *Bacillus thuringiensis* Berl. as a potential means of control of cabbage white butterfly (Pieris rapae L.), diamond back moth (*Plutella maculipennis*), and some other Lepidoptera, N. Z. J. agric Res. 3, 1009-1014.

Hulsenberg (H.) 1929 Observations on the occurrence of *Plutella maculipennis*, Curt., in the Erfurt Cauliflower District in 1928, Die kranke Pflanze, 6, 88-91.

Kanervo (V.) 1933 The diamond back moth, a serious vegetable pest, Puutarha 35, 71-74.

———————— 1936 The diamond back moth as a pest of cruciferous plants in Finland, Valt. Maatalousk. Julk, 86, 86 pp.

Kanervo (V.) 1947 Sporadic observations concerning diseases in certain species of insects, 3. Diseases attacking *Plutella maculipennis* Curt., Ann. ent. fenn. 12, 143-153.

Khristova (E) 1957 *Plutella maculipennis*, Curt. and its control, Nauchni Trud. Minist. Zemedel. 1, 239-255.

Kopvillem (Kh. C.) 1960 Material for the study of parasites of the cabbage cutworm and the cabbage moth in the Moscow region, Rev. Ent. USSR 39, 806-818.

List (C. M.) 1937 Possible migration of diamond back moth, J. econ. Ent. 30, 676.

Lloyd (D. C.) 1949 Host selection by Hymenopterous parasites of the moth *Plutella maculipennis*, Curtis, Proc. roy. Soc. Ent. (B.) 128-853, 451-484.

Lloyd (D. C.) 1942 Further experiments on host selection by Hymenopterous parasites of the moth, *Plutella maculipennis* Curtis, Rev. canad. Biol. 1, 633-645.

Lucien Bonnemaison 1965 Insect pests of crucifers and their control, Annual Review of Entomology 10, 233.

Marsh (H. O.) 1917 Life-history of *Plutella maculipennis* (Diamond-back moth). Jl. Agric. Research 1, 1-10.

Meier (N. F.) 1925 A few words on the biology of *Angitia fenestralis*, Holmgr., and on immunity in insects, Defense des plantes, 2, 147-150.

__________ 1926 The biology of *Angitia fenestralis*, the parasites of *Plutella maculipennis*, and some notes on immunity in insects, Zeitschr. angrew. Ent. 12, 139-152.

Milles (H. W.) 1924 The diamond back moth, *Plutella maculipennis*, Curt. Ann. Rep. Kirton. Agric. Inst. 1923, 45-48.

Miner (F. D.) 1947 Life history of the diamond back moth, J. econ. Ent. 40, 581-5_3.

Morgan (W. L.) 1929 Preliminary experiments in cabbage moth control, Agric. Gaz. N. S. W. 40, 781-766.

__________ 1931 Experiments in cabbage moth (*Plutella maculipennis*) control, 1930, morgcm(W.L.) Agric. Gaz. N. S. W. 42, 57-58.

Muesebeck (C. F. W.) 1922 A revision of the North American Ichneumon-flies belonging to the Subfamilies Neoneurinae and Microgasterinae, Proc. U. S. Nat, Mus. 61, no. 2436, PP. 1-76.

Muggeridge (J.) 1930 The diamond back moth, its occurrence and control in New Zealand, N. Z. J. Agric. 41, 253-264.

Wuggeridge (J.) 1939 Parasitic control of Pests, experiments with white butterfly and diamond back moth, N. Z. J. Agric. 58, 305-307.

Nayar (J. K.) & Thorsteinson (A. J.) 1963 Further investigations into the chemical basis of insect-host Plant relationships in an oligophagous insects, *Plutella maculipennis* (Curtis) (Lepidop-tera: Plutellidae), Canad. J. Zool. 41, 923-929.

Oka (I.N.) 1957 Laboratory experiments on the control of *Plutella maculipennis* with *Bacillus thruiginiensis* Berl., Tehnik pertanian 6, 113-134.

Otanes (F. Q.) & Sison (P.) 1927 Notes on the diamond back moth, *Plutella maculipennis* Curtis, Philip. Agric. Rev 22, 251-254.

Pimental (D.) 1961 Natural control of caterpillar population on cole crops, J. eocn. Ent. 54, 889-892.

Prasad (S. K.) 1963 Quantitative estimation of damage to crucifers caused by cabbage worm, cabbage looper, diamond back moth and cabbage aphid, Indian J. Ent. 25, 242-259.

Predtetohenski (S.) 1925 The cabbage moth, *Plutella maculipennis*, Curtis. Astrakhan Sta. Plant Prot., Leaflet 55, 23 pp.

Reichardt (A. N.) 1921 *Plutella maculipennis*, Curt., Bull. Sub-section control plant pests attacked to the Petrograd Committee of rural economy 1, 6-77.

Robertson (P. L.) 1939 Diamond back moth investigation in New Zealand, N. Z. J. Sci. Tech. (A.) 20, 330-364.

____________ 1948 *Eupteromalus* sp. as a hyperparasite, some indication of its influence on the establishment of *Angitia cerophaga* in New Zealand, N. Z. J. Sci. Tech 29 (B)5, 257-265.

Roman (A.) 1918 Contributions on the Swedish Ichneumonidae Pentagoni, ArKiv for Zoologi, 12, 2, 1-32.

Shaw (M. W.) 1959 The diamond back moth *Plutella maculipennis* (Curtis) a historical review with special reference to its occurrence in Scotland in 1958, Trans. R. Highl. agric. Soc. 6, 4, 56-80.

____________ 1962 The diamond back moth migration of 1958, Weather 17, 221-234.

Shteinberg (D. M.) 1961 Host-parasite relations in entomophagous insects, The possibility of the development of larvae of certain parasites. Hymenoptera in hosts new for them, Dokl. Akad. Nauk SSSR 138, 1477-1480.

Simmonds (F. J.) & Perron (J. P.) 1960 Record of *Plutella maculipennis* Curt. and some of its parasites in Kashmir, India, Canad Ent. 92, 278.

Stuart (A. M.) 1957 *Ephialtes brevivornis* (Grav.) as an external parasites of the diamond-back moth, *Plutella maculipennis* (Curtis) Bull Ent. Res. 48, 477-488.

Swezey (O. H.) 1915 A preliminary list of the Hymenopterous parasites of Lepidoptera on Hawaii, Proc. Hawaiian Entom. Soc., 3, 99-109.

Tanada (Y.) 1956 Microbial control of some Lepidopterous pests of crucifers, J. Econ. Ent. 49, 320-329.

Taylor (G. G.) 1948 Experiments for control of white butterfly (*Pieris rapae* L.)and diamond back moth (*Plutella maculipennis* Curt.) on cabbage. N. Z. J. Sci. Tech. 29 (A) 265-272.

Telenga (N. A.) 1931 Hyienopterous Parasites of the Fam. Ichneumcnidae, reared at the Kuban Plant protection Station in 1927, Plant Protection 6, 225-226.

Temep (W.) 1928 Work against the cabbage moth, Die kranke Pflanze, 8, 121-122.

Thorsteinson (A. J.) 1953 The chemotactic responses that determine host specificity in an oligophagous insect, *Plutella maculipennis* Curt. (Lepidoptera), Canad. J. Zool. 31, 52-72.

____________ 1955 The experimental study of the chemotactic basis of host specificity in phytophagous insects, Candd. Ent. 87, 49-57.

Timberlake (P. H.) 1918 Notes on some of the immigrant parasitic Hymenoptera of the Hawaiian Islands, Proc. Hawaiian Entom. Soc. for the year 1917 3, 399-404.

Todd (D.H.) 1957 Incidence and parasitism of insect pests of cruciferous crops in Hawke's Bay, Wairarpa and Manawatu, 1955-56, N. Z.J. sci. Tech.38, 720-727.

____________ 1958 Incidence and parasitism of insect pests of cruciferous crops in Hawke's Bay, Wairarapa., Manawatu, Rangitikei and Taranaki, 1956-57, N. Z. J, Agric. Res. 1, 847-858.

Torka (V.) 1929 Parasites of the cabbage moth, *Plutella maculipennis* Anz. Schadlingsk. 5, 3, pp. 39.

Tzedeller (O. E.) 1931 The cabbage moth, *plutella maculipennis* Curt. in connection with the cultivation of mustard, Zh. opuitn. Agron. Yu-vostoka 9, 2, 165-195.

Ullyett (G. C.) 1943 Some aspects of parasitism in field populations of *Plutella maculipennis* Curt., J. ent. Soc. sthn. Afr. 6, pp. 65-80

—————— & Schonken (D. B.) 1940 A fungus disease of *Plutella maculipennis* Curt. in South Africa with notes on the use of entomogenous fungi in insect control, Sci. Bull. Sep. Agric. For. S. Afr. 218, 24 pp,

—————— 1943 The control of the small cabbage moth, Fmg. in s. Afr. 1943 repr. 112.

—————— 1946 New species of *Apanteles* (Hym: Bracon.) and new host records from South Africa, J. ent soc. sthh. Afr. 9, 28-35.

—————— 1947 Mortality factors in populations of *Plutella maculipennis* Curtis (Tineidae: Lep.) and their relation to the probelm of control, Ent. Mem. Dep. Agric. S. Agric. 2, p6. 6, 77-202

vvan Emden (F. I.) : 1942 A Tachinid parasitic on *Plutella maculipennis* Curtis., Bull. Ent. Res. 33, 223-225.

Venkatraman (T. V.) 1964 Experimental studies in superparasitism and *Hymenobosmina rapi* (Cam.), the larval parasites of *Plutella maculipennis* (Curt,') Indian J. Ent. 26, 1-32.

Vos (H. C. C. A. A.) 1953 Introduction in Indonesia of *Angitia cerophaga* Grav., a parasite of *Plutella maculipennis* Curt., Contr. gen. agric. Res. Sta. 134, 32 pp.

Voukassovitch (P.) 1927 Observations biologiques sur les parasites de *Plutella maculipennis* Curtis (Lepidoptera: Plutellidae), Rev. Path. veg. Ent. agric. 14, 113-118.

Watanabe (C) 1939 A new species of *Apanteles* bred from Daimio tethys Menetries with notes on other species, Insecta Matsumurana 13, 129-131.

Wilkinson (D. S.) 1939 On two species of *Apanteles* (Hym. Bracon.) not preciously recognised from the Western Palaearctic Region, Bull. ent. Res. 30, 77-84.

BIONOMIC STUDY OF *PLUTELLA MACULIPENIS* CURTIS

Kou-Chai Wu

SUMMARY

Observation method:

The total number of observation was 20. The studied material was taken the pupae from field and caged in bottle which covered with cheese cloth. After emerging, picked up the copulating couple and induced into 4 X 10 cm vial provided a complete leaf of green petiole variety of Chinese cabbage and near the leaf base was surrounded with moistened cotton for egg laying and maintenance leaf fresh. The number of eggs, duration of adult life were recorded in the morning and afternoon twice a day respectively.

Picked up and put the egg laid leaf into clean vial for recording egg stage. The hatched larva was picked up separately with wetted Chinese pen and put into clean vial which had

provided with fresh, clean leaf for feeding. Number of moults, larval stage, pupation, emerging, pupal stage, preoviposition, oviposition, died and adult stage were recorded.

Observation results:

1. Adult: Based on 485 adult record, the female ratio was 51.9%. The adult emerged usually from 7 to 9 AM until 3 to PM. Male and female took copulation usually in evening and laid eggs in next evening. The copulation period lasted from 20 minutes to 2 hours. The adult activity started from 6 to 11 PM. Egg laying period took 3-5 days, the shortest was one day and the longest 8 days respectively. Number of eggs laid by one female based on 36 female record was 18-245 and 121 in average.

2. Egg: Egg was laid on the main or branched vein and sometimes on the petiole of leaf, single or 3 to 4 eggs serially arranged more on the underside than on the upperside of leaf. The egg color was white in first then changing to yellow and brown just before 1 to 5 hours of hatching. Egg stage was 2-7 days and usually 3-4 days. Percentage of hatching based on 306 egg record was 91%.

3. Larva: There were 4 larval stages, The body length of lst instar was 0.8-1.5 mm., anal legs unforked; 2nd instar 1.5-3.5 mm., anal legs forked; 3rd instar 3.5-6.0 mm, broaded along middle and narrowed at both ends; 4th instar 8.5 mm., The totel larval stage was 6-19 days and 9.6 days in average. In constant temperature of 23°C. was 9-10 days and 4, 2, 2, 2, days of lst, 2nd, 3rd and 4th stadium respectively. The larva usuallv hatched from 7 AM to 5 PM, it took 1 1/3-3 hours and 2 hours in average for completing hatching process. 15 to 40 minutes after hatching, it began to search food and spin silk. If the egg was laid on the upper side of leaf, it usually moved to the underside and mined into leaf tissue as the leaf miner and left the cleared leaf epidermis. The 2nd instar sometimes was still mining in the leaf tissue but most of them fed outside, 3rd and 4th instar fed outside of leaf and made holes, in severe infestation, the feeding hole usually connected each other and just left leaf veins, the petiole was also infested. The larva when was being disturbed usually spinning silk and moved backward. When moulting it span silk and wove to fix its body. If lack of food, it span silk to be spreaded by wind or migrated by walking for searching food. The consumption of food was very few in lst and 2nd instadium, but in lst and 2nd day old of 4 instadium consumed lots of leaf, based on 40 larva record was 275.40 mm. square of leaf in average for full larval stage.

The mortality of larva was low, about 5%. There were 2 species of Braconids *Apanteles plutellae* Kurdj. and *A.* sp. which parasited in 3rd to 4th instar. The percentage of parasitism was 37.5% in without chemical control field. The braconid laid eggs in the 2nd and 3rd instar larva of *Plutella*, its egg including larval stage took 7-10 days, after maturation, it came out from the host larva and span coccon beside its host for pupation, its pupal stage took 6-8 days, from egg laying to adult emerging took 15.3 days in average.

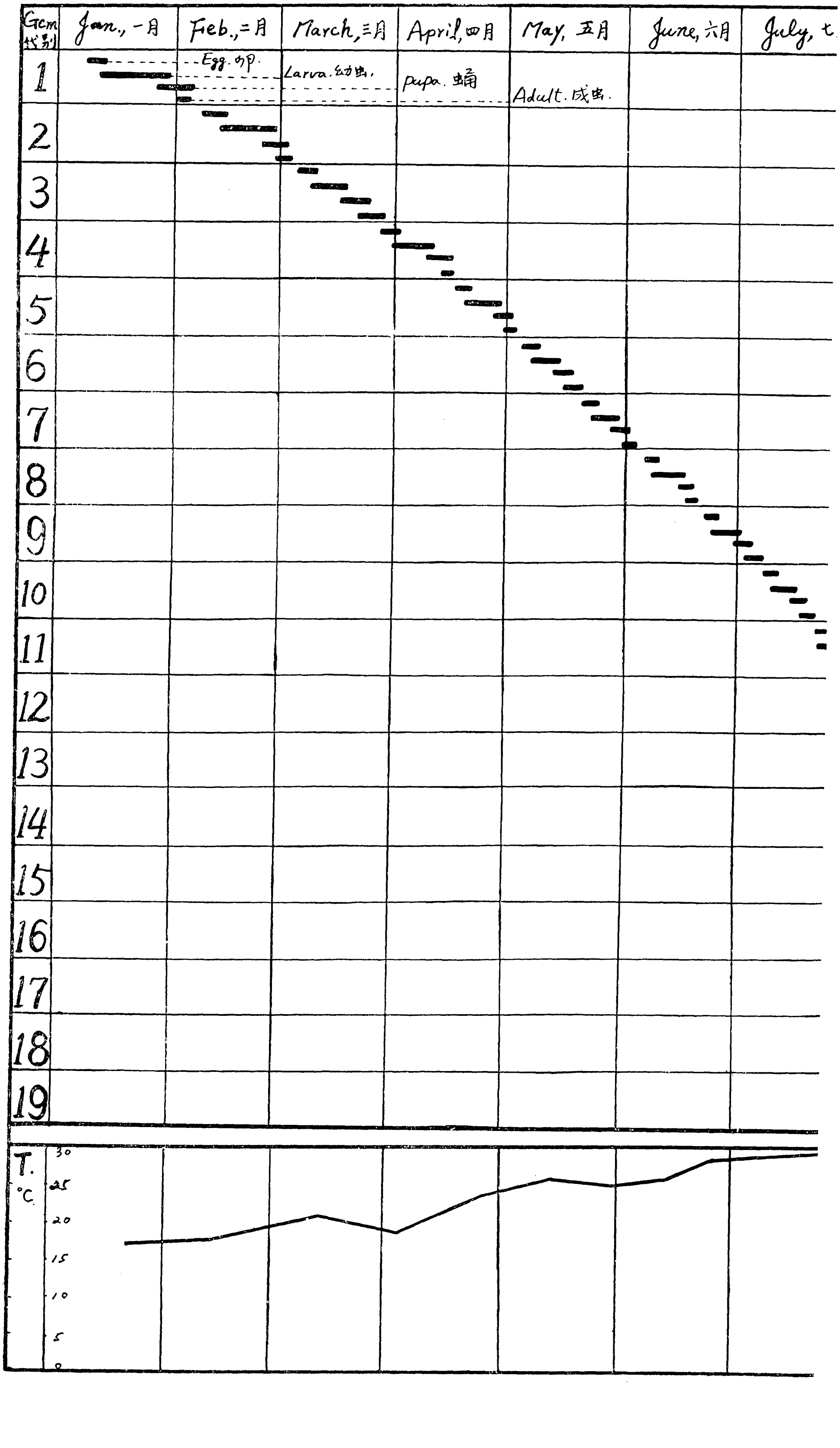
4. Puap: Before 3-5 hours of matured larva stopped feeding, span silk to weave spindle loose cocoon along veins in concave place of underside of leaf for pupation. The larval skin was discharded at the end of pupa within the cocoon. The pupa color was initially green then turning yellowish green, yellow. The pupal stage took place 3-12 days, in constant temperature 23°C. was 4-5 days. The mortality of pupa was .very low, but it was

usually parasited by a species of Ichneumonid, *Diadromus* sp. (probably *D. collaris* Gravenhorst). The percentage of puapl parasitism in without chemical control field was 34 to 44%

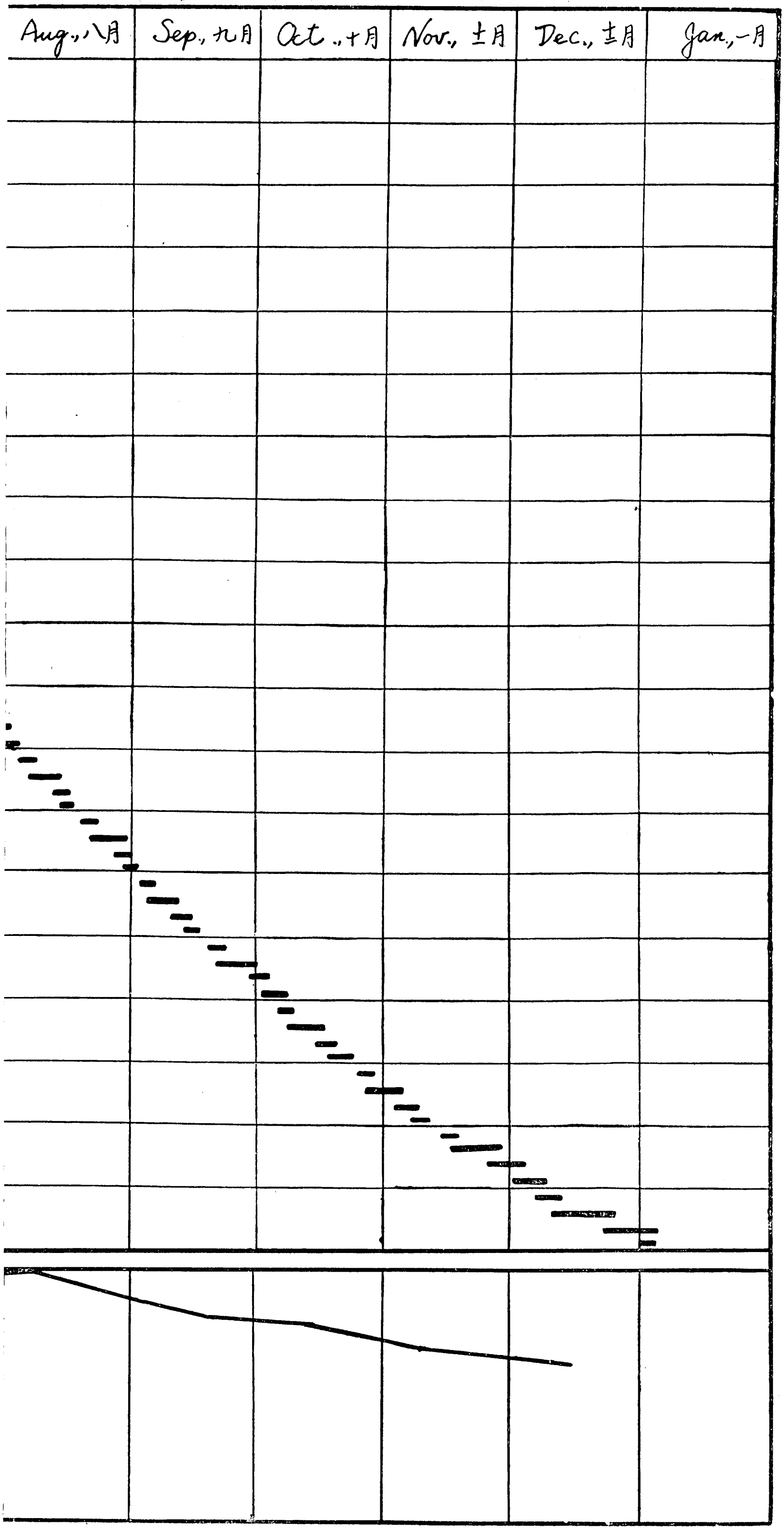
5. Annual generations: This observation was made form June, 1965 to July, 1966. It hac 19 generations in room temperature and 18 generations in outside of room annually. Tc complete one generation was 13-34 days in room and 13-37 days in field and 17-20 days ir constant temperature of 23°D. respectively

6. The outbreak of dimond back moth on this island since the extensive use of nev development insecticides like DDT, BHC, malathion, parathion, diazinon etc which were easily to build up the resistant strain due to the quick development and could not establisł its effective larval and pupal parasites to check the diamond back moth in uneconomic level For overcoming this difficulty, it seems to have to change the control method beside insecticides.

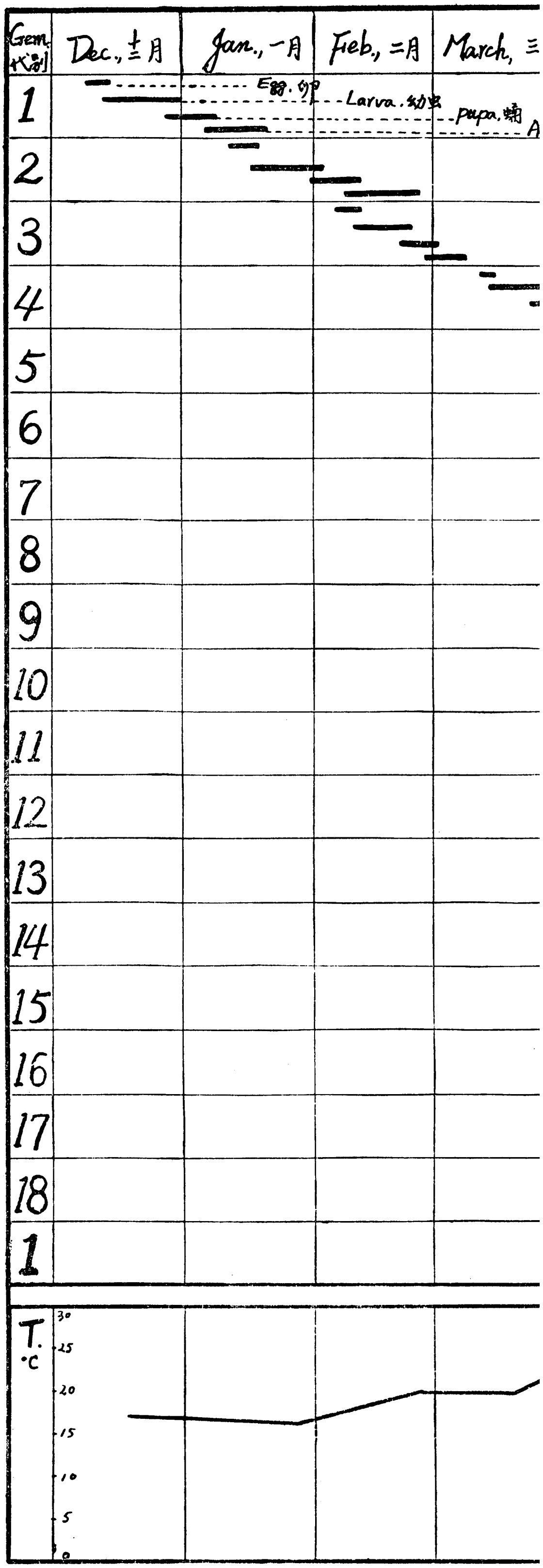
圖二 Fig. 1. Seasonal Appearance of Diamond Back Moth in Room



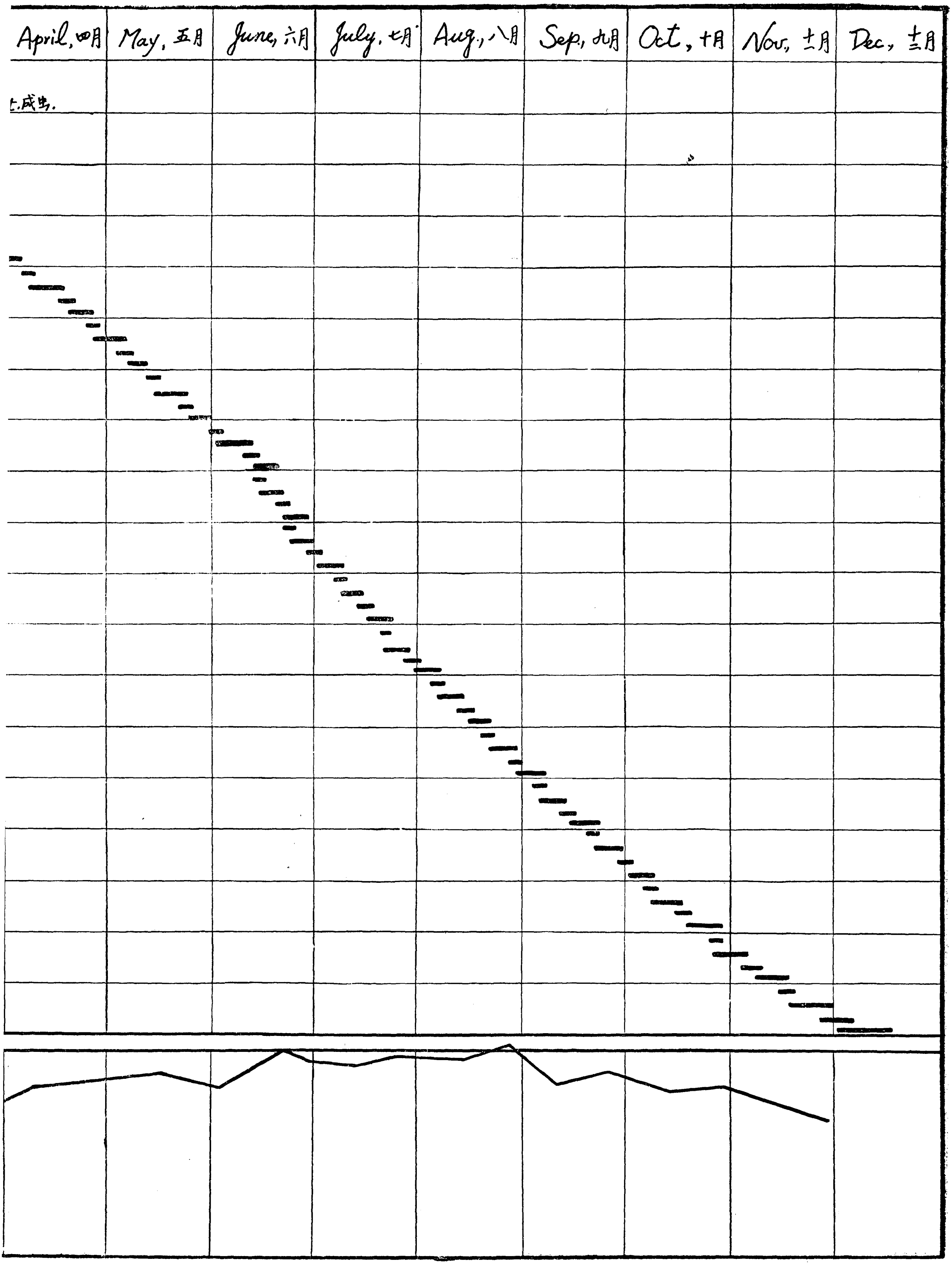
'emperature (June, 1965—July, 1966) 小菜蛾室内生活年史



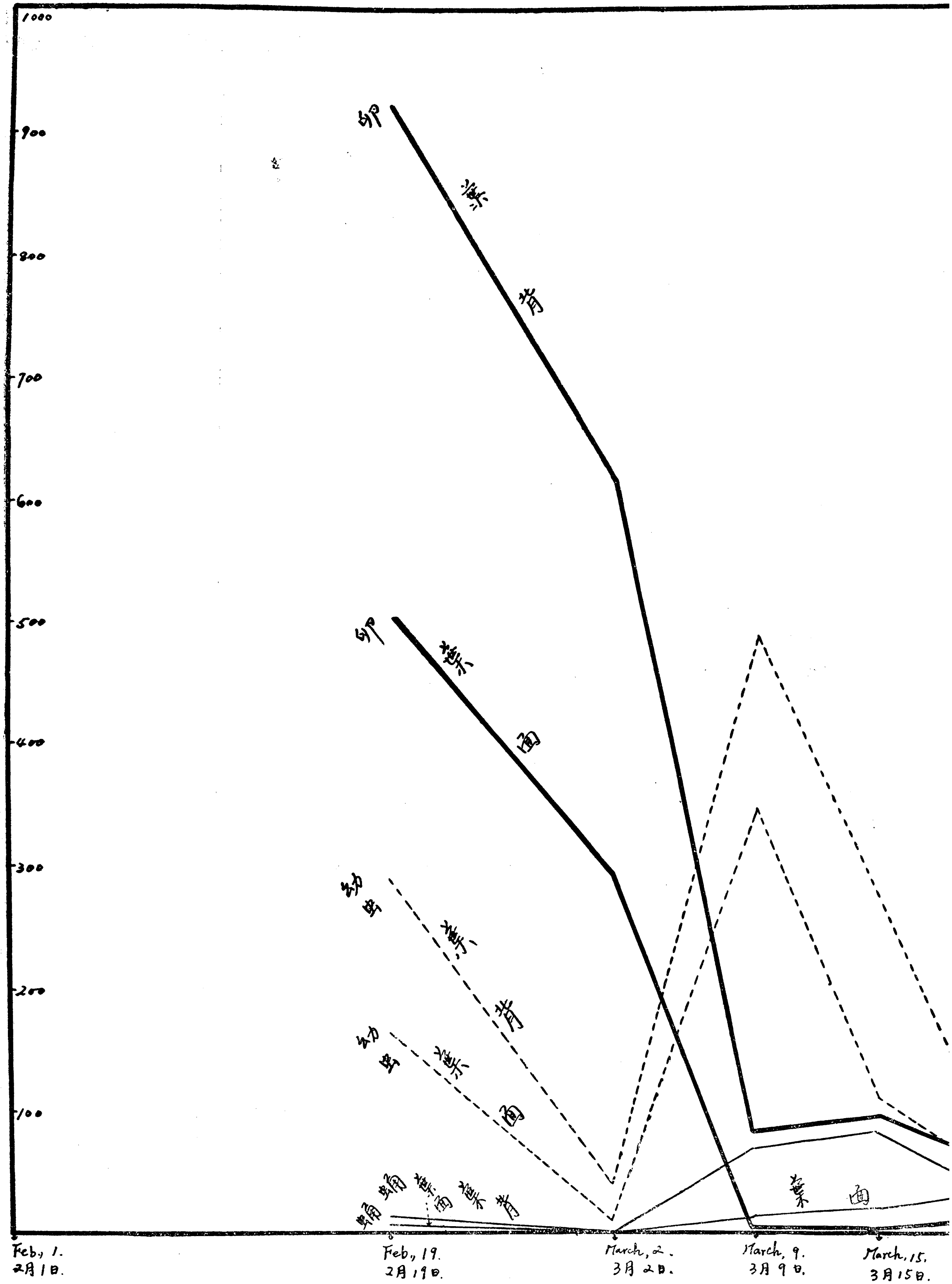
圖三　Fig. 2. Seasonal Appearance o

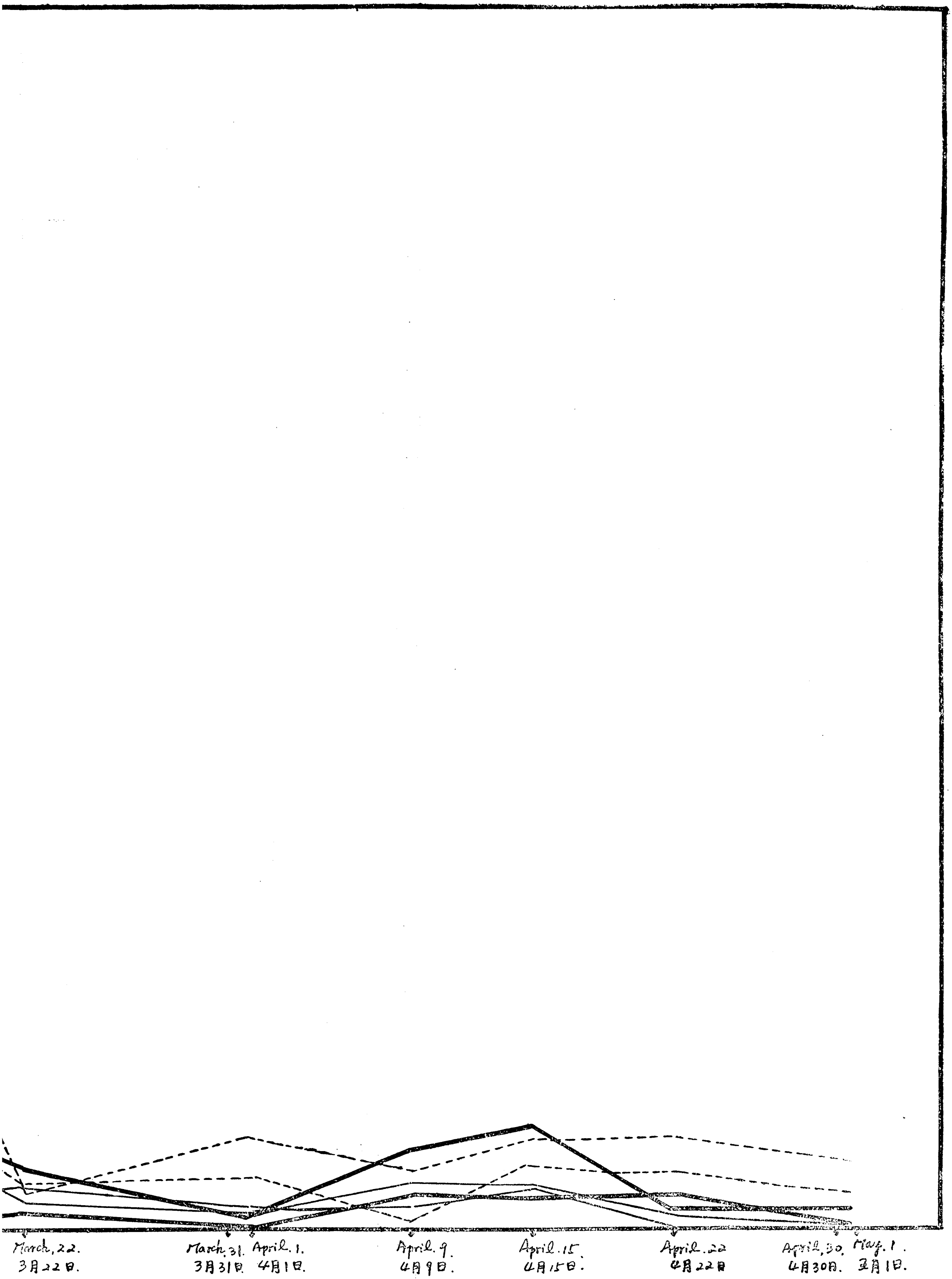


Diamond Back Moth in Field Cage Temperature (June, 1965—July, 1966) 小菜蛾室外生活年史



圖四 Fig. 3. Field Population Survey of Diam




March, 22.
3月22日.
March. 31.
3月31日.
April. 1.
4月1日.
April. 9.
4月9日.
April. 15.
4月15日.
April. 22
4月22日
April. 30.
4月30日.
May. 1.
5月1日.

文　獻　介　紹

ABSTRACTS OF LITERATURE

一、稈長，穗長，生長期及細菌性白葉枯病之遺傳〔Heu, M.H., T. T. Chang 和 H.M. Beachell (1968) 育種學雜誌 18 (1):7—11〕

利用臺中在來一號和高的印尼稻 Sigadis 雜交以研究稈長，穗長，生長期及細菌性白葉枯菌之遺傳行爲。

Sigadis 之稈長由105到135公分平均爲117公分。而臺中在來一號則介於55 到65 公分，平均59公分。其 F_2 植株分佈介於40到160公分之間。雖然呈現連續性之分佈，但仍有兩個明顯的峯（modal）。故認爲是受一對因子所支配。理論與實測亦很符合。

穗長的分離情形較爲複雜，並呈現負向歪度（Negative skewness）。假定其是受呈9:6:1分離之兩對因子所控制。

若將穗長和稈長合起來成株高。其F_2植株分佈亦呈雙峯型（Bimodal）。適合於受一對因子控制之現象。另用 Casttle-Wright 和 Wright 之公式計算，亦表示是受對一對因子所支配。

生長期之遺傳，則受五對因子所支配。因子間呈多因子累加性之作用。同時，假設臺中在來一號具有其中之三對，Sigadis 則攜有其他兩對。

細菌性白葉枯病之遺傳行爲，則呈三峯之連續分佈。因區分點之不同，可得3：1或1：2：1兩型，但均表示是受一對因子所支配。

其他有關性狀間之相關，環境因子，感光性因子對上述農藝性狀之影響，亦曾討論到。（嚴盛添）

二、菜豆之感光性遺傳及連鎖研究〔Coyne, D. P. (1967) J. of Heredity 58 (6):313-314〕

利用矮性菜豆 Gallatin valley 50 和White Seeded Tendergreen（不感光）和蔓性之Great Northern Nebraska #1 sel 27（短日性）間之什交後代，研究開花期及長短日與生長期間之遺傳及相互關係。

兩雜交組合之F_2，其開花期均表示是受主要因子所支配。且適合於9：7（晚對早開花）之比例。故表示是受兩對互補因子所支配。但生長習性則均表示是受一對因子所支配。蔓生是顯性性狀。

由於有許多之親本型之出現及獨立性測定之結果，顯示此兩性狀間有相吸（Coupling）之連鎖情形存在。進一步計算結果發現 GV50×Nebraska #1 sel. 27和 White Seeded Tendergreen ×Nebraska #1 sel. 27各有 14.9%和 7.9%之連鎖值。（嚴盛添）

三、有關稻熱病菌混合接種之研究〔清澤茂久和藤卷宏（1967）農技研報 D-17:1-20〕

爲找尋具有不同病原性之病原菌系統間呈現於寄主上之相互作用，乃進行混合接種對愛知旭和關東51型水稻病斑發展之影響以及兩者病斑型之比較；胞子濃度對病斑發育之影響；在不同環境條件下混合接種之影響；先接種無毒性（Avirulant）系統後對有毒性（Virulent）系統之病原反應上之影響等七大試驗。

其結果發現，當一品種接以有毒性强和無毒性兩種病原菌之混液時，感病型病斑數目較單獨接種時減少。此種抑制感病病斑發育之作用可稱之爲表面的混合接種影響（Apparent mixture inoculation effect）。此種表面混合接種影響包括眞正的混合接種影響（True mixture inoculation effect）和濃度影響（Concentration effect），後者是當胞子濃度增加時，反而抑制了感病病斑之形成。

而且有Pi-a抗病因子之愛知旭品種，其表面混合接種影響大於具有Pi-k因子之關東51號。而此關東51型之表面混合接種影響，可大部份歸諸於濃度之影響。迄今尙無眞正混合接種影響被發現。

此種表面混合接種影響，可認爲既非只是主

效抗病因子 (Major gene) ,亦非其他微效因子 (Minor gene) 所控制。同時,品種間並未發現有濃度影響之不同。此外,當一寄主接以有毒性系統後數天,再接以一無毒性系統時,愛知旭和關東51號兩品種上均可發現有感病病斑發育抑制之現象。(嚴盛添)

四、水稻對矽之吸收及其分佈之研究〔A. TANAKA and Y.D. PARK (1966) Soil Science and Plant Nutrition12(5): 23~27〕

使用印度型稻種 (Peta) 以水耕栽培法設置不同矽量供給之處理,觀察水稻生育期間矽酸之吸收狀況及其體內分佈情形結果,水稻對矽酸之吸收現象是具有選擇性質而與呼吸作用相關聯之積極作用。在作物體內矽酸濃度低時其吸收力尤强。在蒸騰作用旺盛而矽酸濃度低時,由根部吸收之矽酸則移運至幼葉部位,如作物體內濃度較高時,所吸收之矽酸移運到壯葉部位。由此證實矽酸在稻體內之分佈狀態與器管之蒸騰作用有關,同時與代謝作用亦有關係。

實驗中又證實,水稻體內矽酸含量,超過0.3 %時,無論含矽量之多少與乾物產量多寡無關。此現象顯示矽酸與作物生產之間無直接關係,唯有矽高濃度情形下改善作物受光姿態的時候,尤於羣體栽培情形下姿態之改善對增產具有意義,或避免病蟲害情形下可獲得增產。

對養分吸收方面含矽量多時,水稻中氮、磷、鉀、鐵、錳含量較低,此點可避免鐵毒害現象之發生。含矽量少時常發生營養失去調和現象。(李蘭帝)

五、利用熱處理及腋芽培養法滅除馬鈴薯X及S毒素〔Richard Stace-Smith and Frances C. Mellor (1968) Phytopathology 58(2): 199-203.〕

馬鈴薯 X毒素 (PVX) 及S 毒素 (PVS) 爲最普遍發生的二種馬鈴薯毒素病。單獨利用熱處理或莖先端分生組織培養 (meristem tip culture) 很難加以滅除。若同時利用熱處理及腋芽培養 (Axillary bud culture) 則可以顯著地減少此二種毒素。將馬鈴薯塊莖扶芽之一節取下,種植於保持適當濕度之砂土內,待其生根後即移植至四英吋花缽,經四週後即開始加以熱處理。處理氣溫由 33°C變更到 37°C ,土壤溫度由 30°C變更至 32°C ,於日間日光照射。於處理期間每隔一段時間即將新芽取下,經表面消毒後放入無菌水中,並在20倍或50倍的解剖顯微鏡下,將腋芽切下。所切下之腋芽長度需在0.3-1.0 mm之間。將切下之腋芽移至裝有Murashige and skoog 液體或固體培養基之試管內。 置於 24°-27°C 下,連續螢光照射 。待腋芽長出之莖及根長至2-3cm時,即可將此幼苗 (Potato explant) 移植於土內。

PVX 之檢定係將幼苗 (Potato explant)之葉片汁液接種於指示植物 (*Gowphrena globosa* L) 上面;如無反應則可用電子顯微鏡檢查 PVS 之存在與否。如經檢定之幼苗帶有 PVX 則需利用血清反應檢定 PVS 之存在。經過一次檢定後,不帶毒之幼苗,一個月後需要再做檢定,如此,經半年六次檢定後,如仍爲無毒幼苗即可選爲繁殖之用。

本試驗中,經過 8 週熱處理後,不帶 PVX 之馬鈴薯幼苗植株增加到50%,經18週的熱處理後可達到100%。 PVS之滅除則較爲困難,經 8 週熱處理後只有七分之一的幼苗爲不帶PVS者。存活之幼苗植株中51%爲不帶 PVX 者,而僅有11%爲不帶 PVS者。

利用此法繁殖不帶毒素之馬鈴薯植株極爲經濟實用。(林淑媛)

六、小麥稈銹病病的人工培養〔Williams, P.G. et al. (1966) Phytopathology 56 (11):1418-1419; (1967) Phytopathology 57(3): 326-327.〕

銹病菌向來被認爲是一種必須活物寄生菌,但威廉斯等人於1966年使用含酵母抽出物之培養基,已將小麥稈銹病病菌於人工培養基上培養成功。

彼等首先取得不帶雜菌的夏胞子堆。將發病之小麥葉片經15%的 Calsol (3 % available chlorine)加上0.001% Tween 80 (Polyoxyethylene sorbitan mono-oleate) 消毒四分鐘,經三次無菌水洗滌後,置於培養基上,放在乾燥器內,並以400呎燭光的連續螢光照射,經四至五天後即可得到不帶雜菌的夏胞子堆。將此不帶雜菌

的夏胞子移植到含酵母抽出物培養基之培養皿內，此培養基之成份爲Czapek培養基加上0.1%的酵母抽出物，pH爲6.4，將此培養物置於飽和濕度之暗室內，並保持17°C。二天以後夏胞子即開始發芽，四天以後初步分枝，三至四星期以後形成菌落，如果在培養其中加上消化蛋白質則有更好的效果。將此培養物移殖到新的培養基上亦能生長，培養二至四星期即可形成胞子，夏胞子和冬胞子均可形成於子座上。

氏等更進一步將新培養之小麥稈銹病病菌之菌絲及夏胞子接種到小麥上，均可形成病斑及夏胞子堆，經再分離之培養物亦可於培養基上形成菌落及夏胞子堆，此確定了人工培養基上培養之小麥銹病病菌具有病原性。（林淑媛）

七、植食性蟎類化學防治之法則〔L. R. Jeppson (1965) Advances in Acarology Vol. Ⅱ:31~51〕

由於單一作物之密集栽培，作物品質之改進，過量的施用一般的殺蟲藥劑致使蟎類的昆蟲類天敵及蜘蛛類天敵同遭除滅；同時由於不當的施藥致使作物對蟎類的抗性減低。故對蟎類的化學防治爲當前的重要課題。

而作物生長情況，季節與氣候、蟎類出現密度、蟎類之天敵出現之密度等是爲採用化學防治的先決條件。蟎種類之不同，棲息之部位，生活史、活動性及食害習性又爲影響田間施藥果效的主要因素。屬於Tetranychidae科的蟎類一般施用Organophosphorus-type toxicants及Aromatic halogenated thioethers類有效；而屬於Phytoptipalpidae科的蟎類施用Organophosphorus-type toxicants無效，而對halogenated thioethers具中等之防治效果；然而此兩類藥劑對*Tarsonemus*蟎類具特殊的防治效果，同時對*Hemitarsonemus*蟎類也具防治果效。而其他的藥劑如Chloroform及Morestan等則具較廣泛的殺蟎效力，不但對以上所列之種類有效，並且對Eriophyidae科的蜱類也有防治力。又Endrin和Thiodan對Tarsonemid蟎類有效，但對Tetranychid蟎類毫無防治效力。

影響防治效果的因素有六：即殺蟎劑的性質，蟎類自植物取得的營養條件，氣象因子，棲羣密度及遷移與再傳佈之情況，不活性粒子的影響及連續處理程序的安排等，如能把握這些綜合因素，當此綜合因素不利於蟎類時而予施藥，則有事半功倍的防治效果。

然而經常施用一種殺蟎劑，漸漸可使蟎類產生耐藥性或抗藥性之品系，使殺蟎劑對其防治力漸趨失效，因此爲了防止耐藥性或抗藥性品系的蟎類產生，宜用數種作用完全獨立的殺蟎劑混合及輪流施用，盡量避免一種殺蟎劑長期施用。

爲了達到更佳的防治效果，並且保護蟎類及昆蟲類的天敵不致被過度施藥的殺害，目前提倡綜合生物的，栽培的以及化學的防治法，似爲較妥善的方針。（羅幹成）

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